An Introduction To Psychology

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6/11/43

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AN INTRODUCTION TO PSYCHOLOGY

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AN INTRODUCTION TO PSYCHOLOGY

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New York

THE MACMILLAN COMPANY

1934

Set up and electrotyped. Published June, 1927. Reprinted January, 1928; January, June, 1929; February, April, 1930; January, August, 1931; January, April, 1932; September, 1933; September, 1934.

• PRINTED IN THE UNITED STATES OF AMERICA •

PREFACE

Only recently in the history of education has psychology taken an acknowledged place among the sciences. As a branch of philosophy, it had been tinged with a certain metaphysical aspect which made it seem a subject too abstract to be attempted until maturity. The workings of the human mind were a matter of speculation for the learned. Only concrete facts could be grasped by the young.

The situation as it exists to-day is radically changed. Psychology is firmly established as a science; and though it must still be regarded as being in an experimental and theoretical stage, nevertheless, many explanations have been arrived at, and many laws have been satisfactorily proved. Valuable classifications of types of thinking and behavior have been made. Reflexes, instincts, memory, sensations, emotions, and many other phases of mental life are comprehended to a certain extent, and these are all matters specific enough to be understood by the more youthful intelligence.

In designing this book especially for the younger student, we have constantly borne in mind this necessity for clearness. We have not included any disputed material. We have given only that side of psychology which, through experiment and observation, has a definite scientific basis for its various conclusions. We have tried to avoid all possible confusion by means of simplification, examples, and questions of a concrete nature.

Adolescence is, and always has been, a difficult period

of adjustment, and anything that a system of education can do in making this adjustment easier should be done. To this end, we teach the boy and girl physiology and hygiene, that they may understand the mechanism which they inhabit, in its relation to life, health, and society. However, the physical adjustment is not nearly as difficult to make as is the mental, and yet we give out knowledge of the workings of body, while we withhold from the student the simplest laws of the mind. When one considers the many perplexities which confront youth at every turn, the argument for the teaching of psychology in the high school, as well as in the normal school and college, seems indeed a valid one.

There are other more immediate reasons for the study of psychology before the college age. To begin with, the majority of high-school students do not attend college; and this means that only a small percentage of the population knows anything about a science which is of great importance to everyone. Then there are many universal and interesting mental phenomena, such as sensations, illusions, and the like, which can be adequately explained by psychology. A scientific attitude toward such matters prevents the student from putting any faith in fantastic or, what is infinitely more harmful, superstitious explanations. Again, the average student wastes a great deal of time by learning inefficiently. There is not a little value in showing him how, by simplifying the mechanics of study, he may gain some spare time to follow up his interest in the same or a different field.

In these matters, too, we have constantly remembered the needs and interests of the younger reader. We have brought the science as close as possible to the questions

and problems which arise in his mind from day to day. Our examples are drawn from common experiences. We have, moreover, tried to help him form more open-minded and careful judgments; we have explained to him possible reasons for his likes and dislikes; and, as we have already mentioned, we have shown him how he may use his mind to the best advantage. We have, what is more, dwelt on the fact that right and intelligent use of the mind furnishes a sound background for the finest living. We have emphasized the importance of control, effort, and the moral personality, in the hope that the study of psychology may be an encouragement to the younger student to allow his ideas to grow along healthy, rational, and optimistic channels.

We should like to express our appreciation to the following authors and publishers for permission to use illustrations from their texts: B. B. Breese, Gelett Burgess, H. A. Carr, A. I. Gates, C. Judson Herrick, William H. Howell, G. T. Ladd, J. D. Lickley, W. B. Pillsbury, E. S. Robinson, Florence Richardson Robinson, Howard C. Warren, R. S. Woodworth, D. Appleton and Company, Henry Holt and Company, Houghton Mifflin Company, Longmans Green and Company, The Macmillan Company, Psychological Review Company, W. B. Saunders Company, Charles Scribner's Sons, Frederick A. Stokes Company, and the University of Chicago Press.

We are especially indebted to Professor G. H. Betts for reading the original manuscript and offering many helpful suggestions for its revision, and to Dr. E. L. Clark for reading and correcting the proof.

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Evanston, Ill.

CONTENTS

AN INTRODUCTION TO PSYCHOLOGY

CHAPTER I

WHY AND HOW WE STUDY PSYCHOLOGY

Psychology the Scientific Study of Mental Life.
   Why should we study psychology?
   How shall we study psychology?
The Study of Psychology Should Be Scientific.
   Scientific method has five well-defined steps
Scientific Judgment.
   The law of parsimony in science
   The judgment of science
The Growth of Sciences.
   All sciences grow
   Stages of scientific theory
Scientific Assumptions.
   Postulates of science
Psychology as a Science.
   The phases of mental life that must be studied
   The technique of psychology
   How we know that the nervous system is concerned with coördination

Psychology the Scientific Study of Mental Life

Our mental life is by far the most essential part of our existence. We might get along without a leg or an arm or with many marked defects. We might exist without beauty or with defective health, but with deranged mental life man is a pitiable spectacle. Mental life is almost the whole of human existence as it is organized to-day, and it is this marvelous part of ourselves that we

are about to study. It includes such things as thoughts, feelings, memory, attitudes, ideas, impulses, habits, and other things that go to make up what we call personality.

Why should we study psychology? — It is not difficult to find good reasons why we should study psychology.

1. *It teaches us how to learn.* — We spend many years of our lives in school acquiring knowledge to use in later life. Our minds are so wonderfully organized that much of our learning takes place without our knowing how or why. We do not need schools in order to learn, but they have been built up to direct our learning and make it more efficient. By studying how our minds work, we can vastly improve our ability to acquire knowledge. This should guide us not only in school but all through life.

Why can we not learn one thing as easily as another? Suppose you heard someone make the remark about you, "Isn't he a coward?" You would not need to have it repeated more than once in order to remember it very well. You would not forget it for years, perhaps never. But let the teacher say, "*Puer* is the Latin for boy," and you will forget it in a few moments and have to repeat it over and over before you remember it. While psychology will not enable you to learn all things with the same ease, it will explain to you why some things like a personal remark are easily remembered, while others like a lesson are so easily forgotten.

2. *It teaches us to know ourselves.* — Often we do something and after we have done it we wonder why we did it. Sometimes we wish we could undo the thing. Why did our mind play us that queer trick? Why does it make us do a thing and then make us reproach ourselves for doing it? It is only when we understand a machine that we can

expect to control it. To be the master of our minds we must know the principles upon which it works.

3. *It teaches us to get along with other people.* — We all need the sympathy, coöperation, and companionship of other people. Without these, personal control and efficiency are empty and unsatisfying. To get along with people we must understand them. Mutual understanding is always the basis of friendship. Of course human nature is so rich in its variations that one can not hope to learn all about it in a course in psychology, but certain principles can be mastered that will serve as a guide to future study. Having mastered these principles you will find that human nature appears different to you. Persons who irritated you may become fascinating. Your fear in the presence of others may be changed to confidence.

4. *It teaches us how to solve our problems.* — Every living organism meets complex situations to which it must adapt itself, and such adaptation requires a mechanism sufficient for the occasion. Man, meeting, as he does, more intricate problems than any other animal, has by far the most complex mental life. An animal may meet a difficulty by sheer physical force, by fighting its way through. Man, if he makes full use of his powers, reasons his way through a similar situation. If his reason indicates to him that force should be applied, he applies it in just the right place, more effectively, and, perhaps, more economically than a less intelligent animal.

Mental life is the mechanism of adjustment of living organisms. — If we had no problems or difficulties, we should need no minds. Mental activity is the coördinating of all our resources in such a way as to meet effectively the varying situations with which we are confronted. To

study mental life, therefore, we must study what means are used to effect this coördination, what parts of our being are especially concerned in this work, how the work is accomplished, and the ways in which a coördinated response influences the environment of the individual.

How shall we study psychology? — Let us survey some of the methods that we might use.

1. *We might study the lives of great men.* — There are two difficulties involved in such a procedure. The first is that usually such accounts are one-sided. They are designed to bring out the noble elements in the man's character and if there are other factors they are excused. True understanding must get away from any attempt to exalt, to degrade, or to excuse. The second difficulty is that few individuals are great, and so an understanding of great men would be an understanding of a small section of the human race. Biographical studies are valuable but yield little to a deep comprehension of the workings of mental life in general.

2. *We might study the history of the human race.* — To be valuable for psychology, history should be studied as the development of groups of people, of their adjustments to each other, and of their progress through the ages. History as a record of the political strivings of a few leaders is of little value. To study how man has progressed from the age of superstition and barbarism to our present culture is extremely worth while. Again, however, such a study must be supplemented by a study of man as he is to-day.

3. *We might study ourselves.* — One group of psychologists has asserted that this is the only way to understand mental life; but such a method would tell us only about ourselves. Since we are all different this method has to

be supplemented by what others learn about their own mental processes. The danger here lies in the fact that we are very likely to discount any report of the mental life of another which contradicts what we have come to believe about our own.

4. *We might observe the conduct of others.* — This would include how man conducts himself when alone, when with others, and in the face of various environmental situations. More will be said about this and the preceding method later.

5. *We might study the activity of animals.* — Much has been learned about the mental life of man by observing how animals act under certain circumstances. The conduct of animals is of a simpler sort and is thus more easily understood. This is an advantage in the study of psychology. Here one has to be careful to remember that one can only *infer* the laws of human conduct from the behavior of animals.

6. *We might study abnormal individuals.* — Such study is fruitful because it enables us to see traits in an exaggerated form. The observation of a characteristic when it is present in such excess that it produces abnormality gives us a better notion of the workings of that trait than if it were present in a moderate degree.

These six sources are the main ones from which psychology has drawn. In the understanding of material from all these sources or in the use of the special methods which each of these brings out, the essential thing is to make sure that the conclusions that we derive are sound. To assure ourselves of this it is necessary that all our studies and deductions should conform to the rules of science. It will be well, then, for us to pause for a moment to see what is involved in scientific procedure.

The Study of Psychology Should Be Scientific

The most important feature of any science is the method it follows in acquiring knowledge. The subject matter of study may be very different in different instances, from a definite thing such as a stone to such a complex thing as a human being, but the method is the same in each.

Scientific method has five well-defined steps. — 1. *The gathering of facts to be explained.* — The accumulation of facts is accomplished by keen observation accompanied by an insatiable curiosity. The usual tendency is to ignore things that are not already understood, which of course precludes our ever learning about them. The first step toward knowledge is a questioning attitude. Why did I feel that way? Why did I forget? Why did I remember? Why can not John be less afraid of dogs? Why does Tom hate arithmetic when I love it? We may not solve such questions at once, but we certainly never shall solve them if they are never formulated.

2. *The classification of facts.* — It is not enough simply to ask questions or even to gather a vast number of possible answers. All our facts must be arranged in groupings according to their possible relation one to the other. Explanations come through an understanding of relationships, and classification is the first step toward the discovery of significant relations.

3. *Formulation of a theory to explain the facts.* — Such a theory is called a *hypothesis.* It is an attempt to explain causal connections between different facts that have been observed. A caution should be inserted here. It is possible to place such emphasis upon a tentative explanation that it is regarded as a final solution. No matter

how well a theory seems to fit the facts, it must be regarded as a mere guess until the fourth step has been carried through.

4. *Experiment.* — Experiment is the means whereby we determine whether or not a hypothesis is correct. *Experiment is observation under controlled conditions.* In other words, all the factors which might in any way influence the process under consideration are controlled and altered at will by the experimenter. In this way certain results may be claimed for certain conditions.

Let us illustrate what we mean by experiment. Suppose we have a knock in an automobile engine. The problem is to discover what causes the knock. The first thing to do is to get the engine operating in such a manner that the knock is present and then to change one element in the situation after another until we either reduce or increase the amount of the knock by some change that we introduce. We must be careful not to change more than one factor at a time or we may be led astray. Suppose we place a screw driver from each spark plug in turn to the body of the engine. We find that when this is done with a particular spark plug that the noise is increased. Evidently this has some connection with the knock and we assume that the knock is in that cylinder. We may then test to determine whether the knock is changed by the load placed on the engine or by the speed at which it goes, or by other similar changes, and from the findings thus elicited, we may deduce that the connecting rod bearing for that cylinder is loose.

This illustrates what we mean by experiment. One may discover things without experiment. One can take the engine apart and hunt for loose bearings without any

experiment. To arrive at a correct solution with a minimum of effort, experiment is much more effective than a blind search for facts. In fact, many a mechanic (so-called) has taken an engine apart, tightened up all the bearings, and placed the engine in seemingly perfect shape, only to discover that the trouble was still present when the engine was reassembled. A few minutes of scientific experiment will do more to locate trouble than hours of blind search for something loose in an engine.

The difficulty in psychology is that there are some factors that are hard to control. We can, however, produce situations where all elements are kept constant, and then change the one factor that we wish to study with a fair amount of control. The added difficulty simply means that we must be more persistent, use a little more ingenuity, and not be too quick in arriving at conclusions.

5. *The formulation of law.* — The formulation of law follows experiment. We can claim to have found a law only when we are sure that a certain condition will produce a certain result. If in our experiment we have missed some factor that we should have controlled, our law may not be a true expression of facts.

For example, there might be a rapping whose cause we wish to discover. We first observe all the facts connected with the rapping. We find that it comes only when there is a certain person present called a medium, that it comes only when this medium calls upon some spirit to appear, that it sounds in answer to certain questions, and that there seems to be no physical movement that could produce it. Upon the basis of these observations we might formulate the hypothesis that the raps are produced by a

spirit. This would be a hypothesis. Our next step would be to experiment. Our experiment would mean that we would have to control everything that might produce a rap. Obviously, if the room is dark and there is the possibility of people or machinery behind curtains, there are things that we have not controlled, and under such circumstances we would not be justified in believing that a spirit produced the raps.

Where such control has been exercised it has been found that the raps are due to some trickery. In one case after every sort of control seemed to fail to show any material cause for such rapping it was found that the raps were produced by a cracking of the bones in the knee of the medium. Obviously in the realm of psychology one needs to be very careful about accepting a law. The reason is that it is hard to control all the factors that might operate. Hence, most of the things we know about the working of the mind we express as *theories* and not as *laws*. A theory is a hypothesis that has been verified as far as we have been able to investigate but which is still open to further experimentation.

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Scientific Judgment

The law of parsimony in science. — A fundamental principle of science is this: *When there are several possible explanations of a group of observations, science always favors the simplest theory.* This principle is especially important in psychology. The things that we shall study are very complex and have been shrouded in mystery, and in the past there has been a tendency to explain mental things by very complex and involved means. The premature acceptance of an involved explanation will only serve to

give us a false sense of satisfaction and blind us to other facts which might lead us to the true explanation.

The judgments of science. — What science tries to do is to get away from mere opinions. To be sure, judgment is involved in scientific interpretation of facts, but *scientific* judgment has certain characteristics which tend to make it more reliable when followed carefully.

1. *The scientist trains himself to take an impersonal attitude toward the facts he studies.* — This is especially important in the study of psychology. (When one is studying another person, he is very likely to be biased by his own personality in formulating his judgments.) If he is studying his own mental processes, he is even more likely to err. The psychologist must try to be absolutely impartial in the treatment of what he finds.

2. *Scientific judgment attempts to be more precise than ordinary opinion.* — The tendency is to get away from qualitative descriptions to objective and quantitative measurements. Instead of saying that John is rather tall, the scientist would prefer the statement that John is six feet, one inch in height. Science takes the crude opinions of the casual observer and translates them into mathematical or statistical terms. *Mathematics is the language of science.* To be sure, in psychology many of our findings cannot be stated in this language, but the trend is always toward quantitative expression.

3. *Scientific judgments differ from opinions in that the former can always be verified by any one who cares to repeat the experimental conditions which gave rise to the judgment.*— An opinion that cannot be verified in this manner remains an opinion. A judgment should never be considered scientific unless it can be verified.

The Growth of Sciences

All sciences grow. — They begin with the first responses of man to curiosity, and it is only after a great struggle that they attain the stage where the facts that are known are worthy of genuine belief. The growth is a steady affair but four stages may be distinguished.

Stages of scientific theory. — 1. *The anecdotal stage.* — Almost every science has gone through an anecdotal stage. In this stage certain facts are told in such a way that they seem to have a logical connection. These stories sound very fascinating and may be corroborated by subsequent investigation. But it must be remembered that a cleverly told story does not constitute scientific proof. It used to be thought that disease was produced by evil spirits which sallied forth at night. The way to prevent disease was to keep the doors and windows tightly closed at night. Many fascinating tales have been narrated setting forth the invasion of homes by these disease spirits. Science has shown that diseases are caused by bacteria that invade the body. What a difference!

2. *Combating superstition.* — The second stage of science is the combating of superstition. Once a story gains circulation it is believed with great fervor and any attempts to change that belief are resisted. Science must work in silence until it has definite evidence and must then educate laymen to change their opinions. Copernicus delayed publication of his views on astronomy for twelve years because of the opposition he felt sure that it would receive. To-day nobody doubts the conclusions he did not dare to publish. History has shown that education will always successfully defeat superstition.

Hence science does not need to fight in the ordinary sense of that term but to express its findings so clearly that they may be taught to all. Truth is always simpler, more comprehensible, and, once understood, more easily believed than error and superstition.

3. *Simplification and popular expression.* — This is the third stage of science. Anecdotes are very complex. The stages of experimental study are very hard to understand by any one not trained in the particular science involved. But when theories become clearly formulated and, being verified, take the form of laws, they can usually be expressed in terms that anyone can comprehend. Psychology, being a new science, has comparatively little that can be expressed in the simplest terms. This does not mean that this can not be done eventually. It simply means that we still have to do some more experimenting before we reach the maximum of certainty and simplicity of expression.

4. *Prediction and control.* — The final stage of science is that of prediction and control. This is the final test of the validity of our scientific findings. When astronomy predicts that at a certain time there will be an eclipse of the sun, the fulfillment of the prophecy indicates that the law upon which the prediction was based is valid. *Prediction is just the reverse of anecdote.* Anecdote observes a certain occurrence, it goes back and finds incidents that seem to be related to this occurrence, and weaves them all together in plausible sequence. Another might relate other factors in quite different causal sequence and be just as near the truth as far as any proof is concerned. To be able to state that with certain factors in operation we shall get a certain result means that we are

foretelling our anecdote, and fulfillment of a prophecy of this sort is the ultimate test of sound science.

Scientific Assumptions

Postulates of science. — *A postulate is an assumption that is accepted without proof as self evident.* Two such assumptions are essential in science.

1. *The first postulate of science is that the universe operates in a lawful manner.* — The aim of science is, then, to discover the laws that control such operation. If there is any occurrence that looks as though it violated the laws of science it simply means that some factor is operating of which we are unaware or that our formulation of the law is incomplete. The universe is ruled by law. If psychology is to be a science we must make the same postulate about mental life. *We must assume that our minds operate according to law.* There are no more miracles in our minds than there are in the physics or chemistry laboratory. We may mix chemicals in such a way that we have an explosion. Had we known enough, we could have predicted the explosion. When a peculiar mental phenomenon takes place, it is no more a lawless event than the chemical explosion.

2. *The second postulate of science is that nothing is ever lost.* — This is called the postulate of the conservation of energy. This postulate is of value only when our study becomes highly quantitative. Since little of psychology has reached this stage, we need not concern ourselves so strongly with this assumption. Advancement, however, will depend upon our working in line with this postulate.

It will be harder for the student to accept these postulates in reference to mental life than in reference to other

branches of study. One can easily assume these two things in the realm of physics, chemistry, or astronomy. There are old traditions that tell us that each man is a law unto himself, that each of us is free to do as he pleases. We have gone on the assumption that there is no law in mental life. This assumption has kept us in ignorance of the workings of the mind. It has even made man fearful of studying mental facts. Since adopting the two postulates given above; namely, that of the lawful order of things and that of the conservation of energy; we have learned many things about mental life. Let us take these assumptions as a working basis, even if later on we may have to modify them.

Psychology as a Science

The development of science, the method of science, and the postulates of science are the same for any branch of scientific study. But the difference in material with which one works makes each science develop a specific procedure of its own. This specific procedure is called the technique of that science.

The phases of mental life that must be studied. — 1. *Getting information about our environment.* — The *sense organs* are those parts of our beings that give us information about our environment. They tell us what is going on around us. We must see things, hear, taste, smell, and touch things, if we are going to know how to act. Hence, psychology must study the ways in which these sense organs receive impressions from the outside, how they modify impressions so that they can become part of our mental life, and how the different senses combine their activities so that the individual works as a

harmonious unit in the face of a vast number of varying sense impressions.

2. *Coördinating impressions and preparing for activity.* — The *nervous system* is that part of the body which connects all the parts of the body and makes harmony possible. It consists of billions of fine fibers, which spread throughout our bodies and unite the most insignificant portion to the center of coördinating activity. This center is the brain, which lies in the head. These fibers are extremely active. They are continually taking impressions from all our sense organs and conducting them to the brain centers so that our mental activity is changed all the time by the new messages that we are receiving.

3. *Reacting to our environment.* — Reaction is accomplished by motor organs connected to the brain by other fibers, which carry messages from the brain centers to the muscles and glands of the body. These outgoing messages have to be very carefully organized so that our conduct will be to our advantage. One fiber can not be taking a message to the muscles that would make us extend our arm and another to the muscles that would make us bend the same arm at the same time.

Psychology may be studied in these three broad phases. Greatest emphasis, however, is given to the second, the coördinating mechanism of mental life.

The technique of psychology. — 1. *One technique that psychology uses is introspection.* — To introspect means to look in. So when we introspect, we look in at our own mental lives and try to formulate our theories from the information thus secured. Introspection has been of value in studying one phase of psychology, that of our sensations. It is practically the only way of determining

what our sensations are. Even when we try to study the sensations of another person we must depend upon the report that he gives us of what he sees, what he feels, what he hears.

In studying some of the more complex factors of mental life introspection is faulty and has to be supplemented. We have learned that one can not analyze his own motives. He sometimes feels as though he were doing a thing for one reason when it can be proved by experiment that he was doing it for another. This is not because the man is dishonest; it simply shows the limitations of a particular form of psychological technique.

2. *The second technique of psychology is the study of behavior.* — It is the study of the mental lives of others by watching their conduct under varying conditions and circumstances. This technique simply is an extension of the old adage, "Actions speak louder than words." The workings of a man's mind are shown by his conduct. The difficulty is that we often misinterpret his conduct because we judge it by the motives that would live behind a specific act of the same sort in our own lives. Scientific observation of behavior must emphasize the objective attitude and the impersonal interpretation of what it observes.

How we know that the nervous system is concerned with coördination. — There are various ways in which we can prove that the nervous system is the mechanism which produces what we call mental activity.

1. *The nerve fibers from the sense organs to the nerve centers are essential.* — We may have a sense organ in perfect condition, but if the nerve fibers are broken between this sense organ and the nerve centers, the sense

organ is practically useless. For example, it might be very painful to have a dentist extract a tooth, but if he uses a drug which destroys for a time the conducting power of the nerve fiber, he may pull the tooth without the slightest experience of pain on your part.

2. *The motor nerves are essential.* — Again, you may have an impulse to kick, but if the motor nerve to your leg is not functioning for any reason — if, as we say, your leg is paralyzed — your impulse is of no value. You can not kick.

3. *The connecting fibers are essential.* — Suppose, as a third possibility, that your sense organs and fibers connecting them with the nerve centers are intact and the motor fibers from the centers to the muscles are in perfect condition, you can prevent them all from functioning by taking a drug which will prevent the nerve connections from functioning. A surgeon may administer an anæsthetic so that, in spite of the fact that the sense organs receive the painful sensations and the muscles are perfectly able to move (as might happen as the result of the pain were the anæsthetic absent), you lie perfectly calm — your brain does not operate.

These facts all indicate that what we call mental activity is the coördination of the different aspects of our lives. Mental harmony comes from a proper balance of all the parts. It is the function of the nervous system, as we shall see in the next chapter, to furnish this balance and harmony.

QUESTIONS

1. What are some of the problems that are studied in psychology?
2. Give four reasons why we should study psychology.
3. Explain what was meant when some one said, "We study

psychology so that we will know how to get along without so much studying."

4. Why should one who has studied psychology get on better with his fellows than one who has not?

5. What are some methods by which we study psychology?

6. Give some problems that can best be studied by the behavioristic method.

7. Show how you could study about the pain from a tooth by the behavioristic and introspective methods.

8. Show how or what each of these methods has added to our knowledge of psychology.

9. Which of these methods seems to be the more valuable in the study of psychology?

10. How do scientific findings differ from ordinary opinion?

11. Name some contributions that science has made to our common comforts.

12. What are the five steps in the scientific method?

13. By an example from the laboratory or from an ordinary experience of your own, show how each of these steps develops.

14. State the law of parsimony and explain what it means.

15. What are the chief steps or stages in the growth of a science?

16. What is a postulate? Give an example.

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*Note. In this and later chapters the more simple references are indicated by an asterisk. References not thus marked are more technical in character.

CHAPTER II

THE NERVOUS SYSTEM

The Different Parts of the Human Body.
  The differentiation of cell function
  Every part of this system essential
The Nervous System Is the Basis of Psychology.
  The spinal cord and its branches
  The brain
Sense Organs.
  Reflexes
  Complex responses
The Unit of the Nervous System.
  The neurone
  Types of neurones
  The synapse
  Size of neurones
The Brain.
  General appearance of the brain
  The cerebrum
  The cerebellum
  Crossing of fibers
The Autonomic Nervous System.

The Different Parts of the Human Body

The human body may be compared to a modern city. The city is made up of many parts; of buildings, streets, means of communication such as the telephone and telegraph, houses, and people. Some of the buildings are used for storage purposes, some are residences for the people. Some of the people are employed in distributing

the food and supplies, some are engaged in other duties. There are railroads, street-cars, and trucks used for distribution purposes. Every part of the city and every individual living therein has a specific function.

The differentiation of cell function. — Just as a city is made up of many parts, so every individual is complex, being made of millions of tiny cells, all of them so harmonized that they form a single unit. This harmony is made possible by the fact that the different cells have specialized functions. There are bone cells whose function it is to give the body rigidity and protection. There are muscle cells whose function it is to give the body motion. There are blood cells that carry nutriment to the different parts. There are scavenger cells whose duty it is to rid the body of waste matter. The cells that have the most important and most highly specialized function are the nerve cells. Their duty is primarily that of carrying messages from one part of the body to the other. They are consequently the coördinating organisms. *It is this coördinating function that we call mind.* Insofar as it works properly and all its messages are integrated, we have a personality of a well-balanced sort. When our minds do not work properly it is because one part of our message system is pulling against another. It is not all properly integrated. There is not the proper team work.

Every part of this system essential. — We say, "We see with our eyes." This is true. Without our eyes there would be no vision. But with perfectly good eyes and improper coördination with the rest of our being, our eyes would be of little value. With a perfectly coördinated nervous system and a faulty nutritive system

the nervous system would be disturbed and fail to function properly. Our personality consists of all parts of our being working together in harmony.

Each cell of the body is like an individual in a social community. Each has his own function and should work in harmony with every other. The nervous system corresponds to the telephone or telegraph system of such a community. But we cannot say that our nervous system, no matter how essential, is our whole personality, any more than we can say that a telephone system is a city. Our brain alone would not be a personality. Neither would sense organs, digestive apparatus, muscles, and other systems be a personality without a nervous system. It takes the whole being working together. By mental we mean the integrating factor of this whole system and this is what we are to study.

Since team work is the key note of a successful community, team work between the different cells is the secret of a successful personality. Since our mental life is what makes team work possible, it is obvious that our study constitutes what may be considered the most important phase of our lives. We want to learn to keep our being from being divided against itself.

The object of every personality is to adjust itself to the rest of its environment. Such adjustment is a contest and all the time some persons are being defeated. Most defeats arise because of a lack of individual coördination. Therefore, in addition to the value of our study of psychology from a purely scientific point of view, the science should have a tremendous practical value for each one who studies it. It should enable him to get along better with himself and with the rest of his fellow beings.

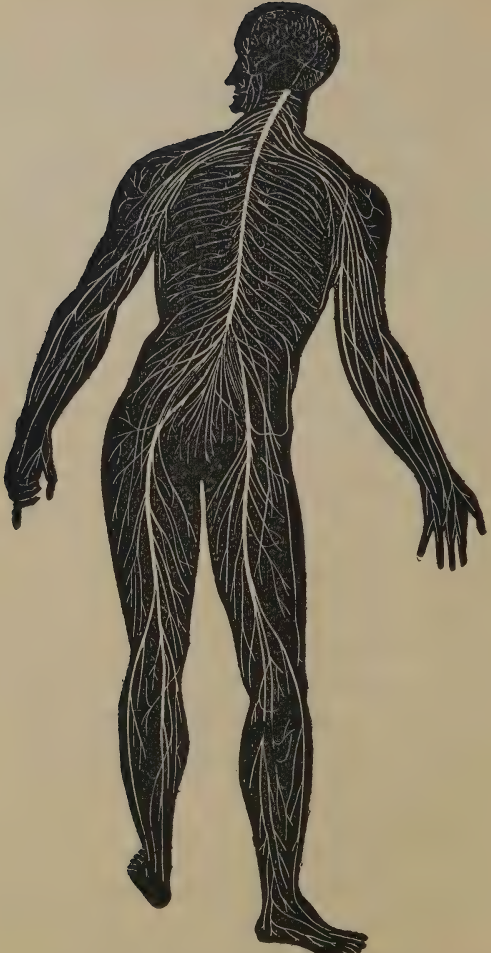

FIG. 1. — GENERAL VIEW OF THE NERVOUS SYSTEM

The main portion, or brain, is shown in the head. The white line extending from the brain down the middle of the back is the spinal cord. Throughout the entire length of the cord nerve branches radiate to different parts of the body. In the upper part branches may be seen extending to the arms and trunk. From the lower end of the cord beginning about the waist line may be seen the fibers running to the legs. Only the main nerve trunks are shown in this figure. Millions of nerve fibers, too small to be seen without the aid of the microscope, must be imagined. (From Carr, *Psychology*, Longmans, Green & Co.)

The Nervous System Is the Basis of Psychology

Since the adjustment of the different parts is the function of the nervous system, psychology is based on the working of this particular portion of our beings. Hence we must know some of the essential things about the operation of the nervous system in order to understand what occurs in our mental lives.

Like the telephone system to which we have compared it, the nervous system has branches extending to all parts of the body. These start from receiving stations (called sense organs) located all over the skin (such as in the eyes, ears, nose, and tongue) and many internal parts of the body. The fibers starting from these stations as they approach the central nervous system unite into groups just as telephone wires are joined into cables. Thus, for example, the fibers that come from the foot start off as fine separate fibers but as they extend up toward the brain they become a part of larger and larger bundles of fibers. What we may see as a nerve (should one be exposed) is not a single nerve fiber but a large number grouped together into a sort of cable.

The spinal cord and its branches. — The main groups of nerve bundles running from different parts of the body to the brain are located in an opening within the spinal column. This big cable is called the *spinal cord.* Branches come in from, and go out to, the skin and the internal parts of the body between each of the vertebræ (bones) as shown in Figures 1 and 2. In all there are thirty-one pairs of nerve bundles (pairs because one comes from either side) branching off from the spinal cord through its entire length.

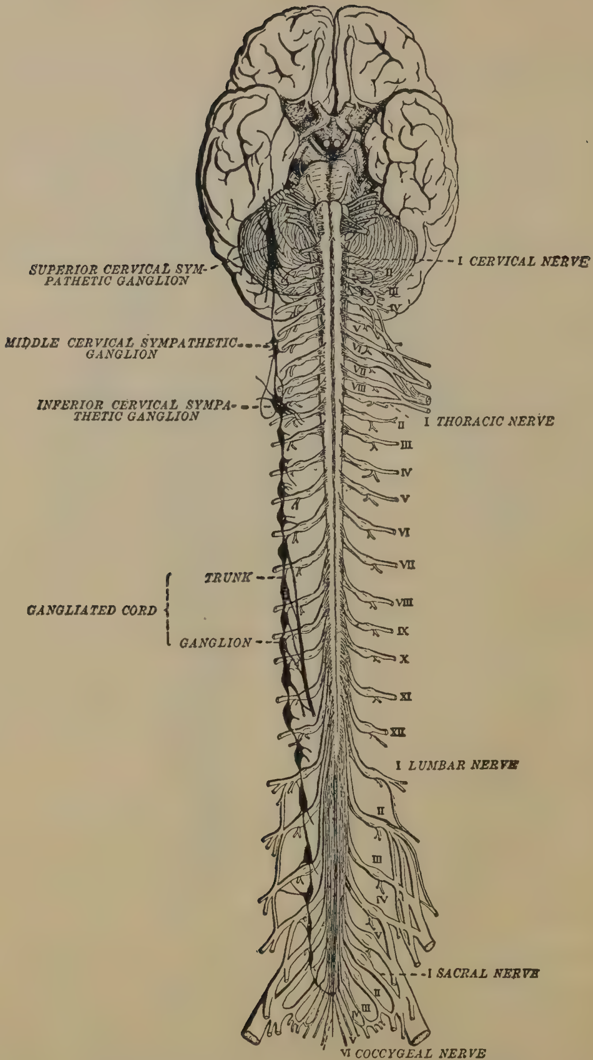

FIG. 2. — DETAILED VIEW OF THE BRAIN AND SPINAL CORD

This figure shows a view of the brain from the under side. From the central part extends the spinal cord with fibers branching out throughout its length (From Herrick, *Introduction to Neurology*, W. B. Saunders Company.)

At its upper end the spinal cord is about a half inch in diameter. Here it joins the brain. Twelve pairs of nerves (each containing a vast number of fibers) come directly into the brain from different parts of the face and neck. The severed ends of some of these are shown branching off at the upper end of the spinal cord in Figure 2. One of these pairs comes from the nose, another from the eyes, others from ears and tongue, and some from the skin surface of the face. All those pathways that run toward the brain are called *sensory nerves* or sensory pathways. Those that run from the brain are called *motor nerves*. Sensory fibers enter at both sides of the cord and motor fibers leave from both sides. Both sensory and motor fibers are bound together in common bundles.

The brain. — The brain is the vast switchboard or telephone central of the body. Anyone who has seen a modern telephone switchboard knows how complicated it is. But the brain is much more complicated than any telephone switchboard. There are approximately two billion sensory and motor fibers in the brain and four to six billion connecting fibers. There is no switch girl at work in the brain. It is all arranged on the plan of the automatic switchboard.

Thus far we have carried through the analogy between the nervous system of the body and the telephone system of a city. There are some important respects in which this analogy does not hold true. One of these is that in a telephone system we talk and receive messages over the same line. In the nervous system the message runs only in one direction. Hence, as we have already pointed out, there is one set of pathways up to, and another set of pathways back from, the brain.

Sense Organs

There are millions of specialized receptors (sense organs) located all over the skin, in the muscles, and in the internal organs of the body. But these receptors are not all the same in construction or function. They do not all receive the same kind of messages. Some of them are tuned to receive vibrations of one kind and some to receive vibrations of another kind.

There are four different kinds of receptors (sense organs) mixed together in the skin. — (1) One kind is affected by objects pressed upon the surface of the skin, (2) another set is stimulated by cold objects, (3) a third by warm objects, and (4) a fourth by strong stimulations of either pressure, warmth, or cold. This last kind gives us the sensations of pain. These receptors are sometimes called end organs. As far as we know pressure end organs will receive only stimulations of pressure. Pain end organs are affected only by things that give us the sense of pain. In other words these sense organs are modified by, or stimulated by, a specific kind of excitation. They are tuned for one, and only one, kind of stimulus.

There are other kinds of sense organs. One kind is located in the eye and gives us the sense of vision. Another kind is in the nose, another in the tongue, another in the ear, and yet another large group in the muscles of the body. These sense organs are the avenues, and the *only* avenues, through which we get information about the world in which we live. There are all sorts of things going on around us all the time. We are oblivious to all parts of this activity except for that part which affects

our sense organs. We shall learn more about this problem in the chapters on sensation.

The sense organs are microscopic bits of specialized tissue. In them the physical forces of the outside world are changed into nervous currents. Sensory nerves are in contact with each of these sense organs and the nervous currents are carried over the nervous pathways, as we have already explained, toward the spinal cord and the brain.

Reflexes. — Unlike the telephone system, not all the nervous currents go all the way to the switchboard in the brain. Some kinds of nervous currents, especially the kinds that give us warning of danger, run only to the spinal cord. There they immediately switch across to a motor pathway and run to a muscle to produce movement. These spinal centers constitute local switching stations which handle urgent messages, those which would require too much time were they handled by the main switchboard of the brain.

For example, when we touch our hand to a hot stove the pain and warm pressure end organs are stimulated and a nervous current generated. This current passes over the sensory nerve to the spinal cord. There, instead of going along a pathway up to the brain, it passes immediately over a motor pathway back to the muscle in the arm. The muscle contracts and the arm is drawn away from the stove. Such an immediate response is called a *reflex*. Reflex means "turn back," and that is what happens.

Complex responses. — On the other hand we may place the same part of the hand upon a warm plate. The same sense organs are stimulated and a nervous current is generated in the sense organ. This current runs over a

sensory pathway to the cord and up the cord to a sensory center in the brain. From there it may run over a connecting pathway to a motor center and then out over a motor pathway to some set of muscles. For example, it may run out to some muscles of the throat and the person say, "warm." This is just one of many responses that might be made. So we can have a current start with the same sense organ and follow entirely different pathways with quite different results. A large part of psychology is taken up with the study of how and why different connections are made with the same receiving stations.

The Unit of the Nervous System

The neurone. — The nervous system, like the rest of the body, is made up of cells. *A nerve cell with all its branches is called a neurone.* The branches are really part of the cell, but they take such unusual forms that this fact, unless emphasized, is likely to be ignored.

The form of the neurone is particularly adapted to the carrying out of its special function. It is made up of a cell body and branches radiating therefrom. (See Figure 3.) There are two types of branches connected with each nerve cell. One is the receiving type and is called *dendrite*. This word is derived from a Greek word, *dendron*, meaning *tree*. The other is the sending type of fiber and is called *axon*. Each neurone consists, therefore, of the nerve cell with its very much branched dendrites and axon as shown in Figures 3 and 4.

Types of neurones. — There are three types of neurones. The first is the sensory neurone, the second the motor neurone, and the third the central or coördinating neurone. The last type is often called the association or correlation

neurone. The different types are shown in Figure 4 and again in a functional arrangement in Figures 5, 12, 13, and 14.

The simplest use of the nervous mechanism involves at least two of these three types. A diagram of such a simple arrangement is shown in Figure 5. Here may be seen the sensory neurone connecting the sense organ with the nerve center and the motor neurone connecting the center to a muscle. The association neurones (in more complex circuits to be described later) are interposed in the central connection system in place of the simple connection illustrated in Figure 5.

FIG. 3. — THE NEURONE AND ITS PARTS

The large black mass is the cell body. The shorter irregular branches above are the dendrites, the receiving branches. The long more extended regular branch extending downward is the axon, the sending branch. Magnified. (From Warren, *Human Psychology*, Houghton Mifflin Company.)

The synapse. — The junction of nerve cells is accomplished by a very complicated meshwork of dendrites with axons. The end of the axon is branched just as the dendrites are branched. Hundreds of axons and dendrites are enmeshed in every nerve center, so that the possible course that any nerve current may take is very varied.

In order that nerve impulses may originate it is essential that something start them. Such a starting element is called a *stimulus*. It is usually some form of energy which

arouses a response in a sense organ adapted to receive it. For example, a sound wave strikes the ear and through the mechanism in the ear it is changed into nervous energy. Light waves similarly arouse a response through stimulating the eye.

FIG. 4. — TYPES OF NEURONES

a. Motor neurone. The cell body is shown at the top with the dendrites or receiving fibers branching from it. The motor neurone has one unbranched axon to the muscle shown below. *b.* Sensory neurone. The receiving end or sense organ is shown below. The receiving fibers of the sensory neurone are longer than the receiving branches of the other types. On the other hand the sending branches shown above are branched to allow for greater connections with the other neurones. *c.* Connecting neurone. This type of neurone is found in the brain and spinal cord and serves to connect the sensory and motor centers. (From Carr, *Psychology*, Longmans, Green & Co.)

This junction between neurones is called a *synapse.* These synapses are illustrated in Figures 5, 12, 13, and 14. This name synapse signifies a "fitting" together and not a "growing" together. This term is used because the

connection between neurones at the nerve centers is believed to have a very special form and significance.

1. *There is probably no direct connection between dendrite and axon at the synapse.* — The terminal arborizations are usually conceived of as being dovetailed together very snugly but all the evidence seems to indicate that there is no direct continuity of connection.

2. *The synapse is a one-way valve.* — Nerve impulses are conducted from the terminations of the sensory axon to the dendrites of the motor cells, but will not pass in the

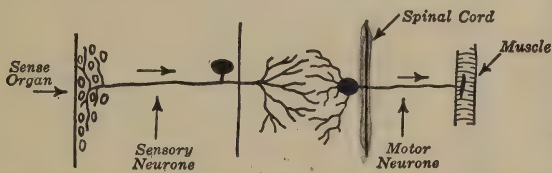

FIG. 5. — SIMPLEST FUNCTIONAL ARRANGEMENT OF NEURONES

The arrows indicate the direction of the nerve impulse from the sense organ to the muscle. Only two neurones, a sensory and a motor, are involved in this arrangement. The central branched or sending part of the sensory neurone is the axon, while the central branched or receiving part of the motor neurone is the dendrite. (From Gates' *Elementary Psychology*, The Macmillan Company.)

reverse direction. By artificial means a nerve current can be made to pass through a nerve fiber in either direction but the synapse permits passage in only one direction. It is this junction point which controls the direction of a nerve current.

3. *There is a greater delay in the passage of a nerve current through a synapse than along a nerve fiber.* — This indicates that the synapse provides a sort of obstruction to free flow of nervous energy.

From these facts it seems that the synapse holds the secret of much that transpires in our mental life. It is

here that the direction of nervous impulses takes place. A nerve current coming in to a nerve center has many possibilities as to the path it will take. The branching at the synapse furnishes many possibilities, but in some manner it also determines just which one of the many is chosen in each case.

Size of neurones. — The neurones vary greatly in length. The length depends largely in what part of the body the neurone is found. The neurones that extend from the foot to the spinal cord are approximately three feet long. Likewise many of the neurones of the motor tracts (or cables) are a foot or more long. These are the extremely long ones. Those that extend from the eyes and nose to the brain are two to six inches long. Others, especially the connecting neurones in the spinal cord and the brain are microscopic in length.

Neurones also vary greatly in diameter. The cell bodies are much thicker than the axones and the dendrites. The axones and the dendrites

a. Neurilemma.
b. White substance of Schwann.
c. Nucleus.
d. Axis-cylinder
R, R. Nodes of Ranvier.

FIG. 6. — PORTIONS OF AXONS

Magnified 250 diameters. The nerve fiber is shown in dark gray in the inside. The black portion is the inner covering and the lighter gray is the outer covering. (From Lickley, *Nervous System*, Longmans, Green & Co.)

are from 1/1200 to 1/100, 000 of an inch in diameter. That is, a nerve trunk the size of the lead of an ordinary pencil would contain from 50,000 to 250,000 separate nerve fibers. Two such axons, greatly magnified, are shown in Figure 6. The optic nerve, that is, the nerve which connects the eye with the brain, which with its relatively thick outside covering is not much more than one eighth of an inch in diameter, is estimated to contain at least 100,000 nerve fibers. In the brain and spinal cord some of the fibers are so fine that they can hardly be seen with the highest powered microscopes.

The Brain

General appearance of the brain. — The brain is a grayish mass of semi-jellylike material. It is roughly divided into four main parts not completely separated from one another but connected by large bands of nerve fibers. The uppermost section of the brain is called the cortex, cerebrum, or hemispheres. This is the largest part of the brain and overlaps all the rest of the brain. It is divided by a groove or fissure which runs from front to back, dividing it almost into halves. (See Figure 7.) This groove is called the central fissure and the two parts into which it almost divides the brain are called hemispheres.

These hemispheres are further subdivided by other fissures. One starts from the under side of each hemisphere near the front and extends upward and backward. This is called the *Fissure of Sylvius*. It is the fissure marked *S* in Figure 8. Another fissure starts near the middle of the central fissure and extends downward across either hemisphere toward the Fissure of Sylvius.

This is called the *Fissure of Rolando* and is marked *R* in Figure 8.

The cerebrum. — The cerebrum contains the various areas or regions where the sensory pathways end as well

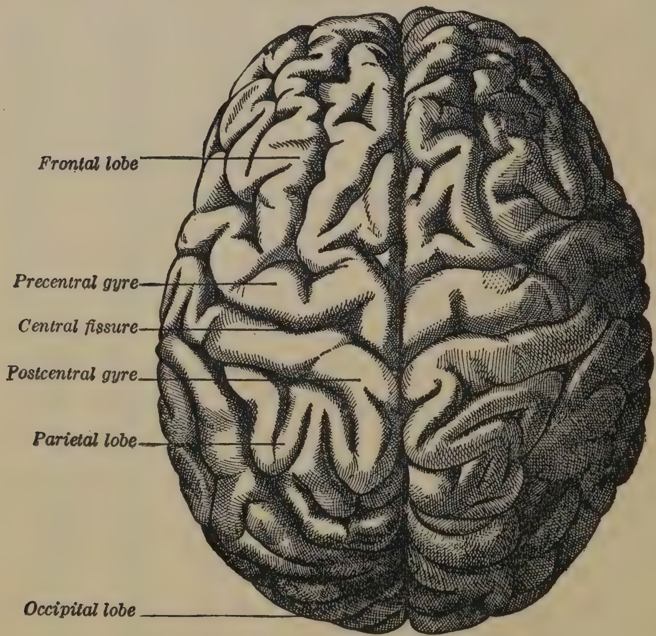

Fig. 7. — Upper View of Human Brain

The brain is divided into right and left halves by a central fissure. The right side of the brain controls the left side of the body and the left side of the brain controls the right side of the body. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

as the areas from which the motor pathways originate. All the sensory areas for pain, pressure, the muscle sense, and other sensations involved in contact end in the area just back of the Fissure of Rolando. This area is

just to the right of the heavy black line which represents the Fissure of Rolando in Figure 9. From this region various central or association fibers extend to other sensory and motor areas of the brain.

The sensory fibers from the eyes go to the visual area located in the extreme back of the hemispheres. This

FIG. 8. — SIDE VIEW OF THE BRAIN

S, Fissure of Sylvius. *R*, Fissure of Rolando. The shaded portion at the lower right is the cerebellum. (From Carr, *Psychology*, Longmans, Green & Co.)

area is shown at the extreme right of Figure 9. The sensory center for hearing is located just below the Fissure of Sylvius as shown in Figure 9.

Ordinarily no stimulus can get to the brain centers except by coming in by way of the sense organs and sensory nerve pathways. However, the centers may

under unusual circumstances be directly stimulated. For example, a severe blow on the back of the head may stimulate the cells in the back part of the brain. Since this is the sensory center for vision, the person may "see stars" as the result of such a blow.

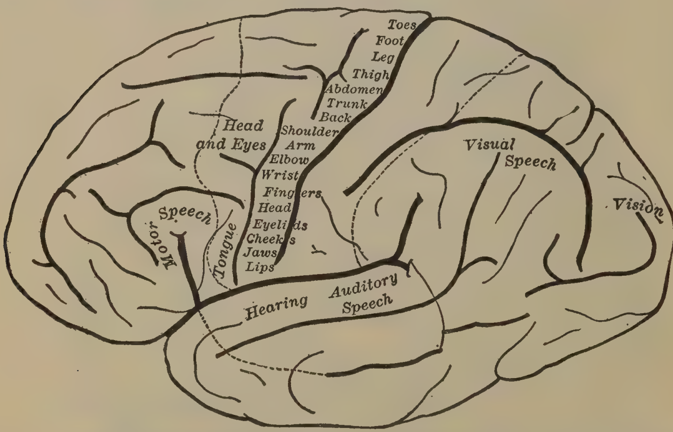

FIG. 9. — DIAGRAM SHOWING SOME OF THE MAIN SENSORY AND MOTOR CENTERS IN THE BRAIN

The main sensory area is behind (to the right of) the Fissure of Rolando, the motor area in front of this fissure. The centers for the lower portions of the body begin at the top of the cortex and as one descends along the fissure one strikes areas connected with progressively higher parts of the body. To the extreme right (the exteme rear) is the visual area. Just below the Fissure of Sylvius is the center for hearing. (From Herrick, *Introduction to Neurology*, W. B. Saunders Company.)

The motor area is located in front of the Fissure of Rolando. The parts of the body to which the motor fibers go from this area are indicated in Figure 9. It will be noticed that the fibers to the muscles in the lower extremities of the body come from the top of the cortex, and as one descends along the Fissure of Rolando one encounters the fibers running to portions progressively

higher on the body until at the very bottom of the fissure are motor fibers going to the face. In other words the position of the motor areas in the brain is just the reverse of the position in the body of the muscles that they control. In front of this motor area is the super-motor area. This is the area that, it is believed, controls highly skilled acts, language, and thinking, although the whole brain is more or less active in all such more complex mental processes.

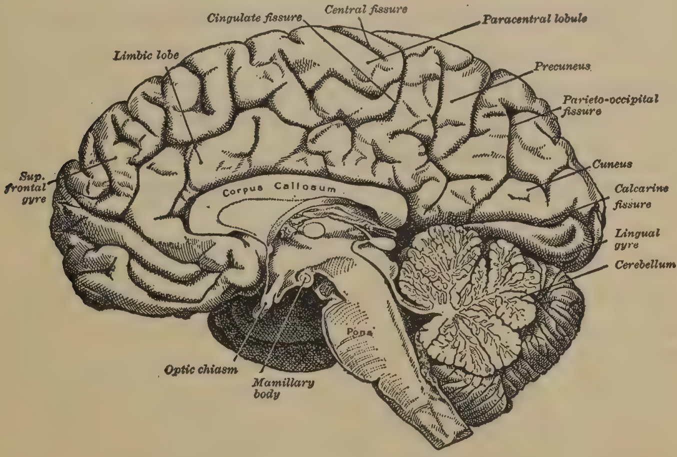

FIG. 10. — MID-SECTION OF THE BRAIN

View of the inside section of the brain as it would appear if cut from front to back downward dividing it into right and left hemispheres. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

Figure 10 shows the inside view of one of the hemispheres. It can be seen that this inside section is filled with folds just as is the outside section of the cortex.

The cerebellum. — The cerebellum is back of, and partly surrounds, the mid-brain and medulla. We know little about the function of this part of the brain.

It is shown as the darkly shaded portion in the lower right part of the brains pictured in Figures 8 and 10. We do know that the cerebellum has some important relation to the sense of balance and position.

Crossing of fibers. — The sensory fibers and the motor fibers cross from the left side to the right and from the right side to the left in the medulla or the upper part of the cord. That is, all the sensory fibers from the right side of the body cross over to the left side on their way to the brain and go to the left hemisphere. From the left side of the body they go to the right hemisphere. Likewise the motor pathways cross so that the motor area of the left hemisphere controls the right side of the body. Therefore a paralysis of the right side of the body is caused by an injury to the left hemisphere of the brain.

The Autonomic Nervous System

In addition to the parts of the nervous system that we have been considering there is a second nervous system which is partly connected with the central nervous system and partly independent of it. This semi-independent system is called the autonomic system.

Ganglia. — It has numerous nerve centers called *ganglia* located alongside the spinal cord, as well as some ganglia in other parts of the body. One of these ganglia is located in the heart. If the heart of a turtle is removed from its body it will continue to beat for some time. It has been demonstrated that it is this autonomic ganglion in the heart that keeps the heart beating in this manner. Another ganglion is in the "pit" of the stomach. A sharp blow over this ganglion "knocks the breath out of you." In other words it has some relation to the function of breathing.

Most of the ganglia of the autonomic system are located in the head and along the spinal column. The part that is located in the head and neck is called the cranial section of the autonomic system. The part in the chest and abdomen is called the sympathetic section. The part that is located in the hips and pelvic region is called the sacral section.

The autonomic system controls the smooth or involuntary muscles and glands of the body. Some of these are the movements of the stomach (called peristalsis), the action of the heart, the secretion of tears, and blushing. You will recognize these actions as the sort of things we connect with feelings and we shall learn more about the relation of the autonomic nervous system to the feelings in a later chapter.

Summary. — This gives us a very brief view of the most wonderful mechanism in the universe — the human nervous system. We have seen that through the sense organs it enables us to keep in contact with the ever changing universe about us. These varied impressions coming in through the sense organs are coördinated through the connections in the central nervous system and impulses sent out to the motor organs so as to enable us to respond to the situation causing the sensory stimulation.

QUESTIONS Journal.

1. The nervous system of the body corresponds to what part of a city? Compare the body and its parts with an engine and show the similarities in function of the different parts.

2. Why is so much emphasis laid upon the study of the nervous system in psychology?

3. What are the main parts of the nervous system?

4. What is a sensory nerve? A motor nerve? Could you tell the difference between them in looking at them under the microscope?

5. What is a sense organ? Where are sense organs located?

6. Name the skin senses. How can you prove that these are different senses and not all one sense?

7. What is a reflex? Name some common reflexes.

8. How does a complex response differ from a reflex?

9. Draw a diagram of a neurone and name its parts.

10. What are the three types of neurones? How could you tell the difference between the different types?

11. What is a synapse?

12. What are some of the changes that take place at a synapse?

13. Give some idea of the size of neurones.

14. Draw a side view of the brain showing the location of its principal parts.

15. What activities are controlled by the cerebrum? Are there any animals that do not have a cerebrum?

16. What and where is the motor area of the brain? The sensory area?

17. What would happen if one or the other of these areas were destroyed?

18. Where is the area of the brain for vision? For hearing? For touch?

19. What is the difference in function between the visual speech and the motor speech areas?

20. Explain how nerve fibers cross from one side of the body to the other and describe the effect of such crossings on bodily control.

21. Tell something about the autonomic nervous system. What body functions are controlled by it?

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CHAPTER III

REFLEX ACTIONS

The Simple Reflex.
- Adjustment
- The parts of a reflex
- Typical reflexes
- Characteristics of reflexes

Modifications of the Simple Reflex.
- Spreading of impulses selective
- Reinforcement
- Summation of stimuli
- Interference of reflexes
- Inhibition
- Refractory period
- Reflexes related to other mental processes
- Reflexes the basis for all complex mental life

The Conditioned Reflex.
- Conditioned responses

Instincts.
- Differences between reflexes and instincts
- Grouping of instincts
- Complexity varies inversely with simplicity
- Instincts are foundations not goals
- Combinations of tendencies
- Study of instincts emphasizes importance of adjustment

The Simple Reflex

Adjustment. — Everything in the universe is continually adjusting to the other things which happen to be around it. If you have a ball suspended by a thread there must be an adjustment between the law of gravity, which tends to pull the ball toward the ground, and the

supporting thread. As long as the thread is stronger than the pulling force of gravity, it will remain poised. Cut the thread and conditions are changed. The ball will drop. Then an adjustment must be made between the ball and the ground it strikes. The ball may dent the ground or the ground may dent the ball or both things may happen. If the ground is level the ball may bounce and return to rest at the spot where it struck, or if the ground slopes it may roll to another place. Hence, even in the world of inorganic matter there is a continual process of adjustment. Each change causes a change of give and take relationships. *Adjustment means that each of the elements in the situation must give something and also take something.*

Man, like the ball on the thread, has to adjust himself to the world about him. The difference is that man has a more elaborate system of possibilities of response to situations and thus is able to make a better adjustment than a stone, ball, or piece of wood. If our head were merely a bit of hard, bony substance and it made a contact with a heavy wall, the head, rather than the wall, would suffer from the meeting. Our mental powers, however, keep us from beating our heads against a wall. The processes taking place within our heads keep us from attempting to remove it by beating our heads against it. Instead, these internal processes lead us to devise hammers, bars, drills, and explosives and with the combined use of these our heads demolish the wall without physical injury to the head. The proper use of mental processes has enabled man to gain and keep control of his environment.

In the last chapter we learned something about the

make-up of the nervous system. Now we must discover how this mechanism operates. To understand a mechanism so complex that it can gain control over the vast forces of the universe, we must begin by studying how this mechanism acts in its simplest forms, and then progress to its more complex activities.

The parts of a reflex. — *The simplest form of adjustment involving the nervous system is called a reflex.* A complete reflex involves five parts.

1. *A sense organ.* — First there must be a sense organ to receive the impression from the outside world. The sense organ is the part of the reflex mechanism that makes immediate contact with the environment.

2. *The sensory neurone.* — The second element is the nerve fiber which carries the impression from the sense organ into the center of the body to the nerve centers or the switching apparatus. These are called *afferent* or *sensory* fibers. Afferent means "carrying toward."

3. *The nerve center.* — The third essential part is the central switching station. In the simple reflex the connection is definitely established so that the nerve current has but one way to go through the central system.

4. *The motor neurone.* — The fourth element is the nerve fiber which carries the impression from the central switching station to the muscle. Such a fiber is called a *motor* fiber or an *efferent* fiber. Efferent means "carrying from."

5. *The muscle.* — The fifth and last element needed is the muscle which acts according to the impulses received through the motor nerve fiber.

Such a reflex is illustrated in Figure 11. Suppose a pin is pressed against the skin. It excites the nerve endings

and this excitation is changed into nervous energy which in turn is carried along the sensory nerve into the central

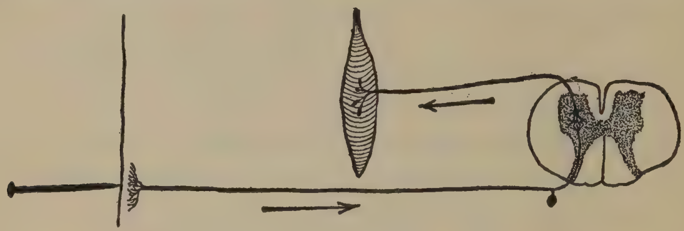

Fig. 11. — Illustration of a Reflex Arc

The pin pricking the skin stimulates the sense organ. The impulse thus set up is carried to the center and a motor impulse sent out to the muscle over the motor neurone. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

connection in the spinal cord. Here it makes contact with the motor nerve fiber and follows this nerve to the muscle which contracts and pulls the skin from the pin point. It must be remembered that this is a simple sketch and that in actual life such a nerve series is interlaced with a large number of fibers and that other things might happen in addition to pulling back the hand. For example, other connection might be made with the speech organs and the victim of the pin prick cry,

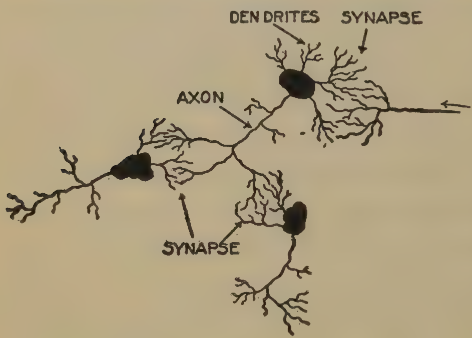

Fig. 12. — Complicated Reflex Arc

The incoming current has more than one possible outlet due to the multiplicity of connections afforded by the two interposed central neurones. (From Gates, *Elementary Psychology*, The Macmillan Company.)

"Ouch!" Each complex addition can, however, be understood as an addition of other fibers connected intricately at the nerve junction points called nerve centers. Such a possible complication is illustrated in Figure 12. Here we have a connecting neurone interposed and another one projected below which might lead the incoming current off into another motor mechanism.

Typical reflexes. — There are somewhat over fifty such reflex connections firmly established in the human nervous system. A few that can be easily demonstrated will be given.

1. *The winking reflex.* — Make a quick movement in front of a person's eye and he will wink.

2. *The pupillary reflex.* — Look at some friend's pupil, noting its size. Permit a bright light to shine into the eye and note that the size of the pupil changes. In the winking the person may have known that he winked his eye. In the pupillary reflex he will not know that his pupil has changed in size when the bright light enters it.

3. *The sneezing reflex.* — The sneeze is not so easily produced at the wish of an experimenter. It is a response to irritation in the nasal passage. A slight whiff of pepper will produce it.

4. *The knee-jerk or patellar reflex.* — Have a friend sit in a relaxed position with his knees crossed. When a light rap is given just below the knee-cap (or patella) the foot will kick outward. Here the tap on the tendon causes a contraction of the muscle that produces an extension of the leg.

Some other very common reflexes are: shivering, hiccoughing, vomiting, yawning, blushing, laughing,

coughing, swallowing, weeping, perspiring, and salivating — or mouth watering.

Characteristics of reflexes. — Let us examine the different reflexes that we have mentioned or described and see if we can discover some general characteristics of reflexes.

1. *They protect the person from possible injury.* — When an object approaches the eye, unless the winking reflex takes place, it might enter the eye and injure it. If a bright light shines continually into the eye it will be injured. The pupil becomes smaller and cuts off part of the light. Undesirable substances in the nose might cause infection. A sneeze tends to expel such harmful substances. This protective character runs more or less clearly through all reflexes. Reflex adjustment is of a very simple sort but it is usually to some situation where hesitation might mean injury.

2. *Reflexes are beyond the control of the individual.* — In some reflexes the response may be somewhat modified but this modification is only partial. Try to keep your pupil from contracting when a light enters and you will meet with complete failure. You may partially prevent sneezing by pressing the upper lip just beneath the nose but this will not always prove to be successful. You may try to keep from winking but let the object come really close to the eye and the wink will occur in spite of effort.

3. *Reflexes are immediate.* — If there is any thought about the reflex, it comes after the action is past. The stimulus causes an immediate reaction.

4. *A reflex is not learned.* — You do not have to practice to be able to perform the reflexes. They are so well organ-

ized that practice will not radically change them. When the nervous system develops it somehow develops the necessary connections so that the reflex will take place immediately. The stimulus sets off a reaction already prepared.

5. *A reflex is a local response.* — It involves only a small part of the whole personality. In the simplest form only two neurones need to be involved. (See Figure 5.) Since there are millions of neurones in the entire nervous system the limited nature of the reflex is evident. In some reflexes more than two neurones are used but the local character of the reflex is never lost.

Modifications of the Simple Reflex

The simple reflex is the most elementary form of adjustment that the nervous system uses. In the living being, however, most reflex activity takes place in connection with other more complex forms of mental life. It is now necessary for us to study how the rest of man's mental life influences his reflex activity.

Spreading of reflex activity. — Since every nerve fiber branches widely, a nerve current coming from a receiving or sense organ not only may go directly to the motor fiber which leads to the muscle giving the reflex response, but it may at the same time be connected with other parts of the body. If you pass your hand quickly before my eye, I may wink. This is a simple reflex response. At the same time the impulse may pass to the muscles of my arm and I may raise my hand to hit you. As I raise my hand other nerve impulses might actuate other muscles and cause me to clench my fist. I might become very angry and as a result the blood vessels of my face become enlarged and my face become red. I might be actuated to

say something to indicate what I think of any one passing his hand in front of my eye. The muscles of my jaw might get tense and cause me to grit my teeth. *In other words, the single stimulus instead of causing only a simple reflex spreads to many other parts of my body.*

Spreading of impulses selective. — Such spreading of an impulse is not at random. It is highly selective. The impulse goes to those muscles which work in harmony. It is the business of the central part of the nervous system, the part where connections are made, to see that the result is a harmonious one. The muscles which make one close one's fist are not stimulated at the same time as those making one open one's fist. Such a random spreading of an impulse would lead to nothing but useless rigidity. This result actually may be demonstrated in strychnine poisoning. This poison breaks down the selective power of the nervous system and all muscles are stimulated equally by any stimulus and the person becomes rigid.

Reinforcement. — It is possible to have two stimuli reinforce each other. This can be demonstrated in a very simple manner. With a light blow just below the knee cap the knee-jerk is produced. Suppose you give several taps at intervals, until you learn about how strongly you must tap in order to produce the knee-jerk. Notice also just how far the person kicks to this tap. Now just as you tap the knee let some one make a loud sound in the person's ear. You will find that the kick is stronger. Ordinarily a loud sound will not cause the knee-jerk but it will increase the strength of the knee-jerk, if it comes at the proper time to *reinforce* the knee-jerk reflex. Another way in which the same thing may be shown is to have the person clasp his hands and pull them violently

as though to break them apart. Under such circumstances the knee-jerk will be strengthened. *This is called the reinforcement of a reflex*, and shows us that reflexes do not work in isolation as a usual thing. They combine and assist each other in enabling the individual to adjust to his surroundings.

Summation of stimuli. — In somewhat the same manner repeated stimuli may reinforce each other. For example, if you touch a feather lightly to a person's neck, he may not respond at all. At regular and frequent intervals, touch him at the same spot. After a time, the effect seems to *accumulate* enough to break through and the person will reach up with his hand to brush away the annoyer. Hence, we have a combined effect of stimuli each in itself too weak to cause a response.

Interference of reflexes. — If two reflexes in opposition to each other are aroused at the same time, they will interfere with each other. Sometimes in such a case neither reflex occurs. In other instances, one may break through and overpower the other. Since they are antagonistic, they can not both occur at the same time. This can be seen in a little experiment that anyone can try on a dog. If you tickle a dog's back just behind his shoulders, he will raise his paw and go through scratching movements. The paw that is to be lifted can be determined by scratching to one side of the spine. You can make the dog alternate from one foot to the other by merely shifting your tickling from one side of the spine to the other. If, however, you tickle both sides at once, you get an interference and it is quite likely that the dog will not raise either paw. If you continue, he may raise first one and then the other. Hence, with the stimulation

of antagonistic reflexes you first (1) get a conflict with no response, then (2) one reflex may break through with an inhibition of the other, or (3) you may get an alternation between the two reflexes.

This illustrates a type of adjustment where the organism seems to get in quite a dilemma over a simple thing and which involves a comparatively simple nervous mechanism. While such an adjustment is very simple, it is similar to the more complex forms that we encounter in mental life. If we understand such a simple dilemma, we can better appreciate what is going on when the human being encounters a situation which involves some weighty decision.

Inhibition. — The process of checking a response in any way is called *inhibition*. Inhibition in nervous terms involves more than mere checking of a process. If you stop a ball that is rolling along the ground, it will come to rest and stay there. Stopping a nervous process has an after effect which is the opposite of the check. After it is stopped, it becomes readier for activity than when it was at rest before the check. In other words, *inhibitions seem to act as partial stimulants*. For example, try to keep your eye from winking when passes are made in front of it. You may succeed for a while but when your eye finally does wink, it will do so with greater vigor than if you had not tried to check it.

Refractory period. — After a reflex has once been aroused, it goes through a short period during which it cannot be made to operate. This is called the *refractory period*. It is probably a rest period which enables the nerve and muscle to recuperate before it again responds. For example, after you have produced the knee-jerk, there

is a short interval during which you cannot produce the knee-jerk. You must wait before you strike the tendon a second time, if you expect to get the knee-kick. This illustrates again the remarkable make-up of the nervous system. You can not wear out the most simple reflex by too repeated stimulation. It will not work the second time until it has recovered from the previous stimulation.

Reflexes related to other mental processes. — From these facts it can clearly be seen that reflexes seldom work as isolated independent units. They are part of a complex organization and their operation depends upon the total condition of the organism, the relation of the particular reflex to more or less closely related units, and what has preceded the reflex activity or what is going on at the same time. A stimulus of one sort can at various times act as a beginning for vastly different reflexes, or for several different reflexes at the same time. One set of muscles can act as an agent for different stimuli at different times, or different stimuli can combine in their effect on one group of muscles at the same time.

In Figure 13 is illustrated the possibility of varied responses to a single stimulus. The stimulation of the sense organ may lead to three possibilities. 1. It may cause a direct and simple reflex involving only one sensory and one motor neurone. 2. The stimulus may go upward over the central neurone in the spinal cord to the section marked "mid-brain level" and stimulate the upper muscle. 3. The result of the stimulation may be a combined response by both muscles. In a similar manner, one might have several sense organs, when stimulated, combine in their influence over one muscle.

Figure 14 shows a still more complex arrangement of central with sensory and motor neurones. Here cells in the cortex (the outer layer) of the brain are involved. The central muscle in the figure is stimulated by a current passing through two central neurones up to the brain and one central neurone returning to the motor neurone. The addition of each possible connection adds to the

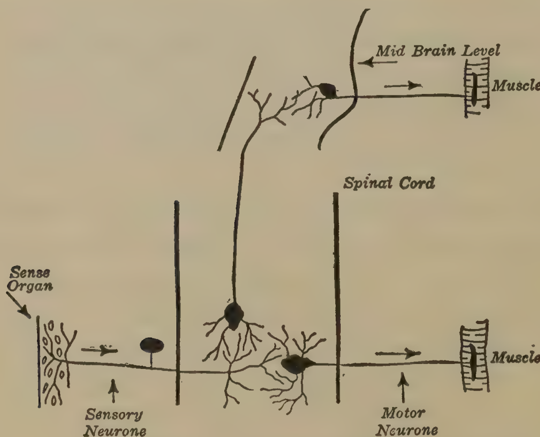

FIG. 13. — COMPLEX REFLEX

The sensory impulse has two possible connections with a muscle. One a simple reflex connection with a motor neurone, the other through a central neurone. Or, a single impulse may produce a response in both muscles and result in a coördinated response. (From Gates, *Elementary Psychology*, The Macmillan Company.)

complexity of the nervous organization which is almost beyond conception, when we get up to millions of neurones.

Reflexes the basis for all complex mental life. — As we progress in our study, we shall see that increase in complication does not change the nature of the elementary reflexes. It merely changes the relationship or team work between them. Studying our mental life is like studying a game in

which vast numbers of persons are participating. We can select a particular individual and study his plays and

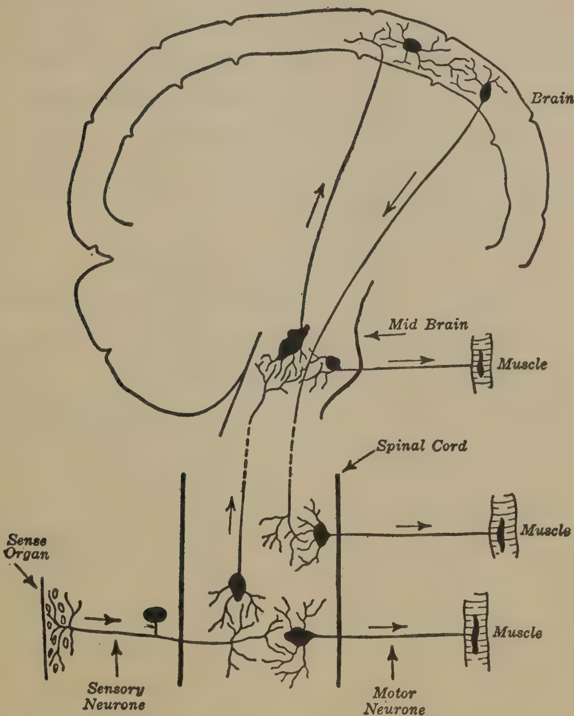

FIG. 14. — COMPLEX REFLEX

This illustrates a still further complication than Figure 13. The sensory stimulus may still find an immediate outlet to a motor nerve or it may pass through a series of central neurones involving connections in the brain. Complex connections are involved in such highly coördinated acts as driving a car or operating a typewriter. (From Gates, *Elementary Psychology*, The Macmillan Company.)

analyze his every move, but this does not give us an adequate understanding of the game. We must study each player in relation to the team. If he does not show

good team work, he is a handicap to the team no matter how perfectly he may be playing as an individual unit.

So in studying our mental life, studying a reflex is like a glimpse at an individual player. The value of a reflex comes in its relation to the rest of life. Each simple reflex is just a part of a vast mental organization whose purpose it is to adapt to surroundings. If the whole organism does not pull together, we shall find faulty adaptation and the individual will lose in the game of life.

The Conditioned Reflex

Certain simple reflex mechanisms are established at birth. — They do not have to be learned. The pupillary reflex is an example of this type. As soon as the baby is born, his pupils will get smaller when stimulated by a bright light, and get larger when he is placed in the dark; the glands in his mouth will secrete saliva when his tongue is properly stimulated; he will draw back his hand from a painful stimulus; and so on for some fifty reflexes.

Reflexes may be changed. — We have said that it is one of the characteristics of a reflex that it is relatively unchangeable. This is true of the simplest reflexes, but these are few in number and form but a small part of our whole mental life. Most of our responses are more complex in form than the simple reflex and these complex forms are being changed continually. We can best understand these more complex modifications by studying how a simple form is changed. Having studied such a pattern, we can understand how the human individual becomes so changed through the different experiences he faces. We shall discover that the human adult is quite a different being from the infant as he appears at birth.

Conditioned responses. — Certain conditions surround every response the child makes. These conditions change his reflex and more especially his more complex responses. We say, then, that when they are so changed they are conditioned. Hence *a conditioned response is one that has been established by environmental conditions, while an unconditioned response is one that is independent of environmental conditions.* When we speak of behavior being conditioned we simply mean that it has been changed by experience.

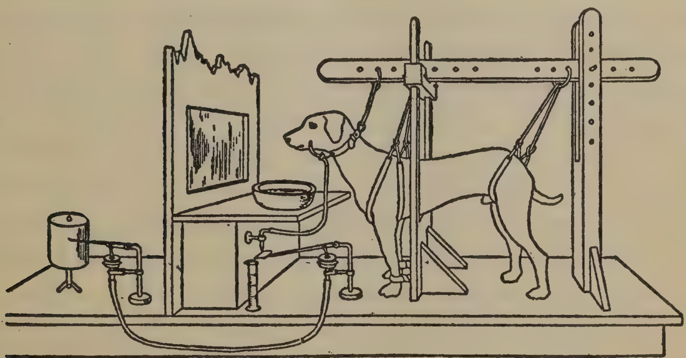

FIG. 15. — PRODUCING A CONDITIONED REFLEX IN A DOG

The tube running from the dog's mouth is connected directly with the salivary gland so that every drop of saliva secreted by this gland drops on the plate placed beneath the outlet of the tube. The impact of each drop is carried to the smoked drum at the extreme left of the picture. In this manner the change in salivary secretion is registered. (From *The Psychological Bulletin*, 1909.)

1. *The first form of conditioning is that in which an ineffective stimulus* (or *an inadequate stimulus*) *becomes effective.* — For example, if you show a dog a piece of meat, his mouth will water. If you ring a bell, it will not. The meat is an adequate stimulus for the secretion of saliva but the ringing of the bell is an inadequate stimulus. If, however, on a number of consecutive days, you present

to the dog a piece of meat and at the same time ring a bell, you will find that the ringing of the bell alone, no meat being present, will cause a flow of saliva. The flow of the saliva at the sound of a bell is called a conditioned reflex. (See Figure 15.)

A large number of changes in our mental lives are formed in just this manner. The ability to grasp irrelevant things and connect them with inborn responses is a tremendous asset to the human race. The ease with which these conditioned reactions can be established is a measure of adaptability or, what we shall later call, learning ability.

This fact was illustrated in a laboratory experiment. We placed the paw of a white rat on a grill so that we could give him an electric shock of a mild sort. When he received the shock, he would raise his paw from the grill. If we rang a bell he would not raise his paw. After we had given him a shock and had rung the bell at the same time for nine trials, he would raise his paw when the bell was rung even though he received no shock. The response of raising his paw when stimulated with an electric shock had become conditioned (or modified) so that he now raised his paw when he heard the bell. In other words, we might say that we had taught him to lift his paw at the sound of the bell.

We tried the same test on a guinea pig but the guinea pig did not learn the trick at all. We gave him over two hundred shocks and he still could not learn.

On the other hand, a little boy who happened to be in the laboratory learned a similar lesson in one trial. His ball ran under a radiator and, in trying to get it, he burned his hand. One trial was enough and instead of burning it over and over again trying to get his ball, he came and

asked his father to get it for him. In other words, he acquired a conditioned response in one trial, the white rat in nine, and the guinea pig never.

An intelligent child is modifying his behavior by this conditioning all the time and often in ways that we do not suspect until the relation is established. One day a mother was very much surprised to hear her little boy say that he did not like oranges and refused to eat one because, he said, it tasted like castor oil. His mother had administered a dose of castor oil in orange juice in order to kill the flavor of the medicine. The castor oil had modified his reaction to the orange juice (had conditioned it — to use the term we have learned), so that now the taste of orange juice produced disgust just as the castor oil had in the first place.

Many of our likes and dislikes for people, our tastes and aversions for various things in life, are built up in just this manner. We have long forgotten exactly how we received the training but the effects are there just the same. The boy referred to above will probably forget the particular incident when he was forced to take castor oil, but he may have a distaste for oranges for the remainder of his life.

2. *The second type of conditioned responses is that in which some stimulus becomes connected with a different response.* — Suppose a child sees a dog for the first time. He may put out his hand and stroke it. This is a very common tendency. The dog may, however, be vicious and bite the child's hand. This will cause the child to withdraw his hand and from that time the sight or sound of a dog, instead of inducing a patting reaction, will cause the child to fear and run from the dog. Here we have

the same stimulus (the dog) but the response has become radically changed as a result of experience. Running has been substituted for patting.

It is quite likely that most of our fears are developed in this manner. Infants are afraid of relatively few things; probably only of loud sounds, the sudden removal of support, and a sharp pain. Other things soon become connected with these and the child then becomes afraid of other things just as he relates them in his experience to the things that originally caused fear. The child is not naturally afraid of lightning but he is of loud sounds. The connection of the two can easily set up a fear of lightning alone. This explains why many people are afraid of things which in themselves should not be a source of fear. Having been established in this manner, the conditioned fear is just as real and powerful as an inborn fear would be, sometimes even stronger.

Instincts

Some of the lower animals have a large part of their conduct determined by a nervous system which makes their form of adaptation very uniform. They have a large number of reflex pathways very firmly established. Placed in a definite situation there is only one way for them to respond. When the reaction pathways are already connected firmly, the animal cannot learn very much. If a stimulus sets off a particular motor organ, the animal will act in accordance with its nervous make-up even if such an action means its death. For example, a moth, when a bright light strikes it, is impelled to fly toward that light. The light may be hot enough to destroy the moth but it flies into the light just the same.

Other animals, slightly more complex in their structure, may have such a reflex pathway but at the same time have a counteracting reflex. This may be the moving away from a hot object. In such an animal there will result a conflict of reflexes, should he be brought into the presence of a bright light which also gives off great heat (such as an arc light). This animal will move toward the light, until the heat becomes intense, whereupon the other reflex will impel him to move away from the light. In this way it is possible to get a balance of reflex impulses.

As we advance in the animal scale, the reflex pathways are less and less numerous, and most stimuli have the possibility of arousing a vast number of different responses. The particular response that is made in such a complex animal as man depends upon the combination of stimuli that happen to be operating at the time. *Responses that are too complex to be called reflexes but at the same time are too fixed to be accounted for by environmental conditions are called instincts.*

We marvel when we see an animal do things that he never had to learn to do. We may even have the silly wish that we could do things without going through the tedious process of learning. But merely doing things is not cleverness. *Cleverness is the ability to change our manner of doing things as conditions change.* The relation between unlearned acts and learned acts in animals and man may be seen from the rough diagram in Figure 16. The proportions in this diagram may not be accurate but they roughly indicate the relationship. Man's glory lies not in the possession of a multiplicity of instincts but in his marvelous ability to learn. The presence of well-marked instincts in the guinea-pig, for example, make

him an "old fogy" before he is born. What tendencies a man has at birth are vague and ill-defined. He must learn through experience but in this fact lies the possibility of a man becoming a genius.

It is this vast accumulation of learned acts and the relatively small proportion of reflex and instinctive acts

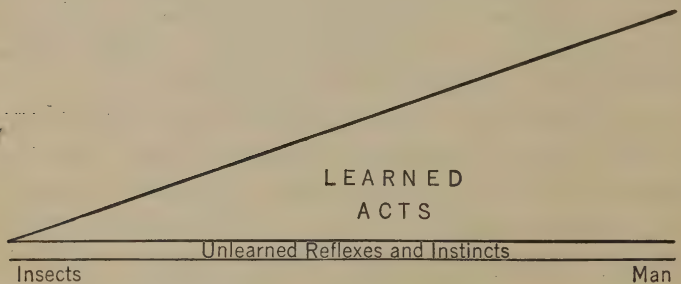

Fig. 16. — Relation of Learned Acts and Instincts in Man and Animal

In an insect very little learning takes place. His life is regulated solely by his mechanism at birth. He goes through his life cycle in a purely mechanical manner. He eats, reproduces, and dies. Man has relatively few unlearned instinctive acts. The vast part of his life consists of learned responses. The insect depends wholly on biological inheritance for his life. Man's greatest asset is his social inheritance. An ordinary high-school student to-day has acquired far more than Plato did in his entire life.

that characterize man and make him so vastly different from the lower animals. The young chick can be hatched in an incubator. As soon as it is born, it begins to walk about, peck at particles of food, and soon is able to take care of itself without any care or training from a mother. If merely kept warm, it is just as well off without a mother as with one. The human infant has to be taught to eat, has to be cared for in every way, and if not nourished, would die.

Differences between reflexes and instincts. — The differences between an instinct and a reflex may be stated briefly as follows:

1. *The reflex is much simpler than the instinct.* — The reflex involves only a small part of the sensory or motor apparatus and only a few central connections. The instinct may involve a large part of the organism and may be very complex. This is a difference of degree.

2. *While a reflex is immediate, the instinct may involve activity lasting over a prolonged period of time.* — When you pass your hand before your eye the wink occurs at once, not three or four minutes or a week later. When a bird builds her nest, the act involves collecting material, carrying it to the chosen point, and assembling it. All this may take days. The bird has never been taught to do this. It does it because its organism is so constructed that it can do nothing else. Such unlearned activity prolonged over an extended period is one distinguishing characteristic of an instinct.

Grouping of instincts. — Most of the human instincts can be grouped under the following five heads:

1. *Nutritive instincts.* — These include all the unlearned activities that have to do with the maintenance of life in the individual, such as acquiring of property (hoarding), wandering about in search of material things, as well as eating.

2. *Reproductive instincts.* — These include all the activities that have to do with the preservation of the species, courtship, mating, and the care of offspring.

3. *Defensive instincts.* — These include flight, hiding, reactions of modesty, the building of homes for protection, and all the other activities that one carries out when made to fear one's surroundings for any reason whatever.

4. *Aggressive instincts.* — These include all the fighting reactions. A child naturally fights and struggles when his personal liberty is interfered with. Hold a little child tightly so that he can not move his arms or legs and he will fight. Faced with a hostile situation, one may fear, in which case the defensive instincts take control (see 3), or one may be stimulated to resist and fight. Defensive and offensive tendencies are thus complementary.

5. *Social instincts.* — There are a group of activities that are called forth solely by the presence of others of our kind. A little child is immediately interested in other little children. As we grow older we are very conscious of the criticism or blame of others. No individual is fully adjusted unless he is adjusted to other people.

These five groups of instinctive conduct form the basis upon which we build in adjusting ourselves to our surroundings. In the order in which they are stated they represent roughly their basic importance and complexity. The first two are the most important, because without provision for food the person would die, and without reproduction the race would die. The defensive, aggressive, and social are decreasingly important for individual adjustment.

Complexity varies inversely with simplicity. — Complexity moves in just the opposite way. The food instincts are relatively simple as compared with the social instincts. The full personal life is the one that adjusts not only to the simpler forms but to the complex ones as well. We must learn that getting enough to eat and reproducing our kind, while essential, must be supplemented by social adjustments in order to provide a full life. In our modern society, personal contacts are so

interwoven with the most basic forms of conduct, that they cannot be separated even in thought.

Instincts are foundations not goals. — The value of the theory of instincts in our study of mental life is that they furnish a foundation upon which to build but never a goal to be reached. The fact that one has an instinctive tendency to run whenever afraid does not mean that he is forced to do so. Man learns to control his fears, to control his tendency to run, to study the situation, and combat his own feelings as well as the situation producing the stimulus to fear.

Combinations of tendencies. — Man has reproductive instincts but he has learned that he gets most satisfaction by combining these instincts with his social and nutritive instincts. The most happiness comes when he has learned to mingle properly the tendencies to provide food, to enjoy human companionship, and reproduce in a family relationship of love. What we may observe in the lower animals as a simple impulse becomes in man overlaid with much learning and expresses itself in a complex form. This is true of all other instinctive activities as well as of the reproductive tendencies.

This fact of the growing complexity in the expression of instincts makes adjustment harder for the human being living in our present civilization. But we have a mental organization capable of just such complex adjustment. Besides, we are learning more about our mental processes as time goes on, and such knowledge makes each adjustment easier.

Study of instincts again emphasizes importance of adjustment. — The question that we have to answer is not whether we will take our organization as it is given

to us and adjust to our environment, or whether we will refrain from attempting to adjust. We are here and we *must* adjust in some way or other. The question is, *how* will we adjust? Since we must adjust, a knowledge of how adjustment takes place helps us to make a better solution of our problems.

Furthermore, we are not helped in adjustment by taking all our cues from animals. Too often we hear the argument, "An animal has the same instincts that we have, he acts thus and so, therefore we should do the same." This argument is false. We have shown that his instincts are different from ours. He is adjusting to a world different from ours. Such an argument degrades the human race. It is our business to modify our instincts so that they will fit into a human society of great complexity.

QUESTIONS

1. Explain what is meant by adjustment. Name some common adjustments.
2. What is meant by saying that gravity causes an object to fall to the ground?
3. Does man make more or less adjustments than inanimate objects?
4. What are the parts of a reflex?
5. What is the function of each part?
6. Give some examples of a reflex.
7. What are five characteristics of a reflex?
8. Could a person learn not to sneeze when pepper gets into the nose?
9. What is meant when we say that a reflex is innate? Name some other innate characteristics.
10. What is meant by the spreading of reflex action?
11. What principle of reflexes is illustrated by the use of an intermittent alarm clock?
12. What is the difference between reinforcement and inhibition of reflexes? Give an example of each.

13. Tap the table or a piece of paper with a pencil as rapidly as you can for half a minute. Count the number of taps. Why can you not tap faster? What principle of reflexes is illustrated by this experiment?

14. Show how reflexes are related to other mental processes.

15. What happens to the child's earliest reflexes?

16. What is a conditioned response? Explain how such responses are developed.

17. What are the two types of conditioned response? Give an example of each.

18. How does an instinct differ from a reflex?

19. What is the great difference between man and the lower animals?

20. Name some of the important human instincts.

21. Which instincts are called the higher instincts? Why are they so called?

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CHAPTER IV

HABIT

Habit the Basis of Human Existence

Universality of habit. — Everyone who has had experience in driving a nail knows how nearly impossible it is to drive a nail that has been bent. Once the nail has bent, it is better to pull it out and use a new one than to try to straighten it. All of us have had an old suit of clothes cleaned and pressed till it looked almost like new. But in a few days the old wrinkles and folds came back. A lengthened sleeve of an old coat will always show the old crease. These examples illustrate the fact that even inanimate objects are permanently modified by the experiences that they undergo.

This principle is even more true in the plant and animal world. The small tree that has been bent over by a snowstorm or by a mischievous boy will never stand as straight as before. The biologists have found that even some of

the single celled animals learn to move away from harmful things and toward food.

We all marvel at the tricks of the pet monkey, the dog, or the elephant. We know that the animal was not born with the ability to perform these tricks. The first performance is often a very difficult thing but after repeated practice, the animal comes to be very proficient in his act. After he has once learned the trick, he is and always will be a different animal from what he was before he learned it. He may, through a lack of practice, become less able to perform but the effect on his organism is to a certain degree a permanent one. All such changes of behavior acquired through experience are called *habits*. Learning is the process of acquiring these changes.

Experiment the basis of human learning. — While a nail can be changed by experience the change is of a simple sort. The possibility of change in an animal is greater and this ability to change with experience increases as we go higher and higher in the animal world. When we come to man, we find that the possibilities for change are enormous. The slightest experience modifies his being. He is continually learning because he is continually experimenting and organizing the results of his experiments into permanent assets which we call habits.

For example, a child learns to walk by experimenting. He first totters across the floor in a very uncertain manner. Later he gets more and more proficient in walking, until it requires no effort. In this manner man learns numerous tricks or habits far beyond the powers of the lower animals. He talks, writes, reads, creates tools and uses them, paints beautiful pictures, and builds sky-scrapers. All these things are dependent upon man's learning ability — upon

the fact that experience changes him and that he organizes these experiences so that they become an integral part of his being.

Man's life is almost entirely habit. Although man, like the lower animals, has reflexes and instincts, man differs from them by having changed the reflexes and instincts until they are often not recognizable. He has substituted habits for these more simple types of action. At birth the child has many unlearned types of response but they are not as definite as they are in the lower animals. Let us emphasize once more the fact that this early helplessness, which might be looked upon as a hindrance, is really the basis of man's superiority. It provides a chance for different kinds of reactions.

Instead of a hard and fast kind of action the child tries one thing and if it does not succeed he tries another. The child is a ceaseless experimenter. He drops his toys or bangs them against objects to see what will happen. Through all this he is learning — he is forming habits which will guide him in later life. The fact that the child spends one fourth of his normal life in getting ready to live, while other animals spend relatively much less time in preparation, shows why man is so much more able to take care of himself under almost any circumstances.

The Basis of Habit

Modifiability and retentivity. — What is the basis of habit? A coiled spring in a door may not lose its elasticity by years of use. A man may be completely changed in some aspects by something that happened only once in his lifetime. Two things account for the difference between the piece of steel and the man. These are *modi-*

fiability and *retentivity. Modifiability means the capacity for change. Retentivity means the capacity to hold or keep whatever change is effected.* Both are necessary in forming a habit. Neither alone is sufficient. Putty may easily be modified. It may be molded at will into almost any shape but it has little retention. It may just as easily be molded into some new form and all the earlier form is lost. A piece of hard metal has almost perfect retention but it is very difficult to modify. Neither the putty nor the metal can form habits, except in the very crude sense that we indicated in the first paragraph of this chapter.

A boy may have to struggle and practice for some time before he learns to swim. But once he learns it he may retain the ability for the rest of his life. In fact he is quite likely to do so. Here we have not only modification but also retention and this is what we call learning a habit.

Basis of habit in the nervous system. — The nervous system is the principal factor in the formation of habit. The nervous system presents one of the best examples of modification and retention. In the last chapter we indicated that some of the connections at the synapses were fixed, as in a simple reflex, while others are relatively loose. These loose neural connections form the basis of modification in the nervous system. An incoming current has offered to it the possibility of a number of different outlets. The one chosen is often a matter of incidental factors existing at the time the nerve current enters. This places the neural basis of modifiability in the instability of the synapse. Let us bear in mind that the main function of the nervous system is to carry messages. Modifiability of the nervous system can mean nothing more than modifi-

ability of connections with a resulting change in the course of the nerve currents.

The retentivity also probably has its basis in the synapse. After a nerve current has once traversed a synapse in a certain manner, it tends to follow the same pathway the next time. We do not know the exact nature of the change that takes place at the synapse when a nerve current passes it but we know from the effects of learning

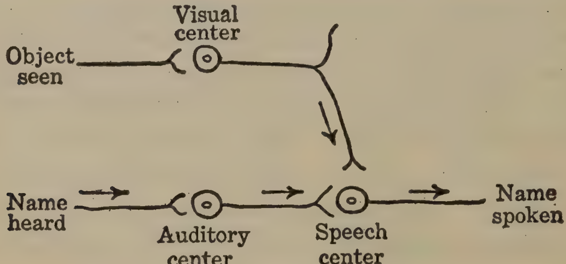

Fig. 17. — Diagram for Learning the Name of an Object

The vocal movement of saying the name is made in response to the auditory stimulus of hearing the name, but when the neurone in the "speech center" is thus made active, it takes up current also from the axon that reaches it from the visual center. This particular synapse between the visual and the speech centers, being thus exercised, is left in an improved condition. Each neurone in the diagram represents hundreds in the brain, for brain activities are carried on by companies and regiments of neurones. (From Woodworth, *Psychology*, Henry Holt and Company.)

that some change has taken place. We can illustrate the change by a diagram illustrating how we learn the name of an object.

In Figure 17 let us suppose that, as a result of hearing a name plus a certain amount of previous preparation, the individual repeats what he has heard. The nerve current set up by the sound of the name goes into the brain to the part represented by " auditory center " in the diagram. It then goes to the part marked " speech center " and then

out to the vocal organs and the person says the name. Remember that this diagram makes the whole thing almost too simple. Actually there might be a hundred or more reactions to hearing the name spoken. The response illustrated is a simple response.

Now, if, at the same time that the name is heard and pronounced, an object is presented to the eye of the individual, he connects the seen object with the name pronounced and thus the two become connected. After the connection is established, the sight of the object is sufficient to cause the individual to name the object. It will be observed that this is the same mechanism we described in the last chapter as the conditioned response.

The possibilities for habit formation are almost unlimited. The billions of connections between the neurones make this possible. A man can form a habit of doing almost anything. As a matter of fact he is forming habits of one sort or another whether he tries to do so or not. The successful person is the one who is forming valuable habits, habits that are of service to him. The worthless person probably forms just as many habits, but they are habits which are of no value to him or to anybody else.

Practical Effects of Habit

The four uses of habit. — We may enumerate four practical effects of habit. 1. Habit simplifies our movements, 2. it makes them more accurate, 3. it diminishes fatigue, and 4. it diminishes the amount of attention given to an act as it is being performed. We will take them up in order.

1. *Habit simplifies our movements.* — We have only to watch a person trying to play tennis for the first time.

The trouble with the learner is not so much that he does not make enough movements. He may even make too many movements, but they are not of the right kind or are not made at the right time. Slow movies have been made of the world's champion tennis player. These pictures show how simply yet quickly and accurately he moves on the court. Pictures have been taken of novices and experts doing different kinds of work. In comparing the records it may be seen that the expert does the job the same way and in the simplest possible manner each time. The novice never does his work the same way twice and he always does it more awkwardly than the expert.

2. *Habit makes our movements more accurate.* — What has already been said about simplifying the movements applies equally well to accuracy. The drop-kicker in football must put in hours of practice in kicking at the goal. The author once saw a Yale sub in a game against Harvard in the only half minute he was in the game. He made a beautiful drop-kick from a difficult angle from the thirty-yard line. He had to time his kick to an accuracy of less than a hundredth of a second. His toe could not vary from striking the ball in the right place by more than one-eighth of an inch. But this sub had spent day after day in practice. His time came and he was the one man who could be relied upon. He did his work and was acclaimed a hero.

The same thing is equally true in industry. The silk weaver must be extremely accurate as errors are very costly. Machinists learn to turn parts to the thousandth of an inch. An accountant becomes so exact that he may add columns of figures all day without a single mistake.

If habit did not simplify our movements and make them

more accurate, we would spend most of the day in trying to dress ourselves and would have little time left to eat, attend to other duties, or even to get undressed for bed. Watch the laborious efforts of the small child in trying to fasten a button or lace his shoes and you will realize what it would mean to have to learn these things anew each day.

3. *Habit diminishes fatigue.* — I once spent half a day in a coal mine. It was a four-foot vein of coal and since I am six feet tall I had to walk stooped over. For the next day or two I found it rather uncomfortable to walk either bent over or straight. The miners told me that for the first few days in the mine, they thought their backs would break. After a while they became accustomed to it and felt no discomfort. If we watch any good workman, either a skilled worker or a day laborer, we can but marvel at what he accomplishes day after day. There are at least two reasons for this. The worker learns to make the fewest and simplest necessary movements and he trains his nervous system and his muscles to accomplish readily the work he has to do. The chief difference between the skilled and the unskilled workman is that the skilled workman trains his brain and the unskilled workman trains or develops his brawn. Since the nervous system is so much more capable of being trained than the muscles, the skilled worker receives the higher pay.

4. *Habit diminishes the amount of attention required for an act as it is being performed.* — Any one who has learned to play a piano or other musical instrument can realize how true this is. At first it takes the whole attention to look at the musical score and then to get the one or two fingers placed on the right keys. Later both hands are brought into play and after a while the fingers automati-

cally find the right keys as the music is read. When the player has become proficient, he can give his full attention to interpretation; or after the selection is learned, he may give his attention to something else while playing.

At the beginning, the attention is painfully focused on each separate part of the problem, first upon the music, then upon the keys, and then upon the hands. As the habits become more fixed the attention takes in larger and larger units until finally the process becomes almost entirely automatic. This is the history of the formation of a habit: first the smallest details; then larger details; then the completed act; and finally the mind is left free to meet and solve new problems.

Laws of Habit

James' four laws of habit. — William James, one of the greatest psychologists that ever lived, gave four laws of habit formation. Probably more good sermons have been preached on these laws than on any text written in the last hundred years. These laws are:

1. *Begin a new habit with as strong and decided a start as possible.* — This explains the value of New Year's resolutions, pledges, and Boy Scout and fraternity oaths. This strong start often carries you along when without it you might never have tried. But first enthusiasms are not enough. Most New Year's resolutions are never tried more than once. Often they are never really tried at all. Once a resolution is made, the second law must come in to strengthen it.

2. *Never allow an exception to occur till the new habit is well-learned.* — Somehow when the old way is repeated, when the nervous current goes over the old pathway, it

is so much easier for it to continue. One break and all the enthusiasm for the new fails and we are back where we were, yes, back farther than we were. On the other hand, if we keep steadfast, and do not permit an exception to occur, the new habit will be formed and become a part of us.

3. *Seize the first possible chance to put the new resolve into practice.* — Do not wait till New Year's Day to make your resolutions or start them. The time to make a resolution is whenever you have the inspiration, and the time to start it is now.

4. *Keep yourself young by a little free practice every day.* — Most of us grow old prematurely. We have fixed ways of doing things, we have fixed ideas, and live in the golden age of the past. It is well to have fixed ways of doing some things. We ought not to spend our best energies deciding when to get up, what to wear, and what to eat. Yet we must be open to new ideas, to new methods. We must be open-minded and ready to accept the truth whether it be new or old. We can best do this, James says, by a little practice of something new, something different each day.

Habits may be either good or bad. A good habit is one that makes it easier for a person to do the things that make him a desirable member of society and to think the thoughts which result in mental unity and efficiency. A bad habit is one that tends to disrupt thinking and to make one's conduct of such a nature that his comrades frown upon him and call him immoral. Right thinking and right conduct may be described as that which will bring the greatest good and the most lasting happiness to the individual and society.

QUESTIONS

1. Define habit.
2. What is the difference between the formation of a habit in a nail, a tree, a dog, and a man?
3. How much of man's life is habit? Of what is the remainder composed?
4. What traits form the basis for habit formation?
5. Show that both retentivity and modifiability are necessary for habit formation.
6. How is the nervous system related to habit formation?
7. Describe how the child learns to speak the word "doll."
8. What are the four practical effects of habit?
9. Give examples from your own experience that illustrate each of these effects.
10. What are James' four laws of habit?
11. Why is it so important not to allow an exception to occur while forming a habit?
12. Does the third law discount the value of New Year's resolutions? Explain.
13. When is a habit a good habit and when is it a bad habit?

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CHAPTER V

SENSATIONS

General Facts about Sensations.
- Classification of stimuli
- Limitations of our sensory equipment
- We are aware of our environment only through our sense organs
- Classification of sensations

The Eye.
- Its parts

Vision.
- Light waves

Facts of Vision.
- Color mixing
- After-images
- Color contrast
- Color blindness
- Peripheral vision

Theories of Vision.

General Facts about Sensations

We have seen that the nervous system is the apparatus of adjustment between the activities of the individual and the environmental situations in which he finds himself. This being the case, the apparatus by means of which the outside events impress themselves on the nervous system becomes very important. If all outside impressions affected the nervous system with equal strength or in the same manner, we would have no way of evaluating their significance. We need to receive impressions but at the same time we need to keep others from entering. Our

sense organs are the gateways to our nervous system. These gateways are tuned to admit certain comers and to exclude others.

In addition to this function of selective reception of stimuli from the outside world, the sense organs have the function of converting external impressions into a form that will enable them to fit in with other nervous processes. In other words, they convert physical and chemical energy into nervous energy. Hence, our sense organ gate-keepers have to take the stimuli that are acceptable and dress them up in a suitable garb, before they are introduced into our mental lives.

Classification of stimuli. — It is instructive to consider the different forms of vibratory energy which our sense organs are adapted to receive.

1. In the first place *non-rhythmic vibrations*, from a slow touch to approximately 1550 vibrations per second, can be perceived by touch or pressure upon the skin. *Mechanical contact* is the adequate condition to arouse sensations of touch from such vibrations.

2. The second type of vibrations are *rhythmical vibrations* of material substances which may vary from very slow movements to exceedingly rapid. Vibrations of this type below about 16 cannot be perceived except as contact or touch. Above 16 they are perceived by the sense organ designed to receive them (the ear) as sound. From this lower limit sound waves are heard to about 40,000 per second.

3. A third type of vibratory energy is *ether waves*. These waves have a range from 0 to 75 billion billion kilocycles. A kilocycle equals a thousand vibrations a second. Out of this great range but a comparatively

small section can be perceived directly by our sense organs. The range given under solar radiation in the table below can be perceived by special sense organs in the skin as heat. The range given under visible rays can be perceived as light and color by the eye.

Type of Wave	Range of Vibration Rate per Second
Electric wave	85 to 10,000
Radio wave	10,000 30,000,000
Hertzian wave	30,000,000 3,000,000,000,000
Solar radiation	56,000,000,000,000 1,000,000,000,000,000
Infra red rays	700,000,000,000 380,000,000,000,000
Visible rays	380,000,000,000,000 770,000,000,000,000
Ultraviolet rays	770,000,000,000,000 22,000,000,000,000,000
X-rays	2,900,000,000,000,000 50,000,000,000,000,000,000
γ-rays — Gamma rays	2,100,000,000,000,000,000 310,000,000,000,000,000,000
Cosmic (Millikan)	4,500,000,000,000,000,000,000 7,500,000,000,000,000,000,000

From George L. Clark, *Applied X-Rays*, p. 6.

Limitations of our sensory equipment. — It can be seen from these facts that man's sensory equipment is designed to respond directly to but a small segment of the energy

manifestations in the universe about him. However, considering his sensory limitations, man gets along pretty well in adjusting to his environment. Especially has he made advances by extending his knowledge of the universe by indirect means. He has invented the microscope and telescope and increased the range of his vision. He has, by a study of natural laws, learned about the ultra-violet and X-rays and has brought them under his control.

It is quite likely that man has always recognized the fact that there were things transpiring in the universe that were beyond his grasp. This will probably always be the case, but the point of view that has enabled man to broaden his comprehension is instructive to bear in mind. For ages the attitude toward the unknown was that of superstition. Superstition is based on fear and so man was tremendously afraid of the unknown. This fear kept him from trying earnestly to learn more about the unknown vistas, or if his curiosity did make him attempt to penetrate the unknown at all, it was to invent some weird explanation that he was afraid to attempt to verify.

The scientific attitude does not minimize the wonders of the universe. It recognizes them more fully than superstition would or ever could. It, however, substitutes for fear, the attitude of curious investigation, until, by dint of extraordinary labor, a little more knowledge is given us about the universe in which we live.

Another tendency that has hampered development, especially in psychology, is that of attempting to explain all mysteries by means of any new discovery. This tendency has come to light over and over again in attempts to explain how we become cognizant of what is going on about us. The transmission of thought from one indi-

vidual to another has been explained at various times by telephone, telegraph, ether waves, wireless telegraphy. All of these means have been used to carry messages between individuals but they must make their entrance into our nervous systems by means of our sense organs. At times silly attempts have been made to trump up such words as mental telepathy in an attempt to explain thought transference.! what!

We are aware of our environment only through our sense organs. — If another person wishes to transmit his thoughts to us, he may do it by translating them as best he can into words, gestures, or writing. These, striking our sense organs, are interpreted and we thus become aware of his thoughts.

Similarly, any impression made upon our sense organs and converted into nervous energy thereby becomes a part of us and it is absolutely necessary for us to adjust to it in some manner. It might be something we would on sober analysis have preferred to keep out, but once it has entered, it has become a part of us and we are different for having received it. This by no means indicates that we must sanction such an undesirable impression. We may as a result guard ourselves so that no similar impression gets by our sense organs, but this is simply another way of saying that we have adjusted to the first impression.

Throughout the long history of the human race there is little evidence that the efficiency of the sense organs has improved very much. *The advance in human efficiency has come about through the development of a more efficient central nervous system.* !

We become aware of the unlimited fields that do not directly affect our sense organs, through the indirect means

of scientific analysis and we make intricate adjustments through the increasing complexity of our nervous systems. For example, we cannot perceive directly ether waves of high frequency, but through radio apparatus we can put these waves to our service and make them carry messages for us. In order that we may better understand the sorts of impressions that we are receiving we will first examine our various sense organs. We shall then take up our study of the more intricate mental adjustments that take place in our central nervous system.

Classification of sensations. — The sensations that we receive may be classified as follows:

1. Sensations of vision.
2. Sensations of hearing.
3. Sensations of smell.
4. Sensations of taste.
5. Skin sensations, including:
    a. Pressure
    b. Pain
    c. Warmth
    d. Cold
6. Sensations of balance or equilibrium.
7. Sensations of movement.
8. Organic sensations.

The Eye

Without doubt the most valuable sense organ that we possess is the sense organ of vision, the eye. It is a very complex and delicate mechanism designed to receive light waves, transform them into nervous energy, and then transmit them in this modified form to the neural fibers which carry them to the central nervous system. It

operates essentially as a camera operates. The similarity of the eye to an ordinary camera is shown clearly in Figure 18. The main difference, as we shall see, is that the camera must be adjusted by some outside agency while the eye is adjusted by means of the nervous system.

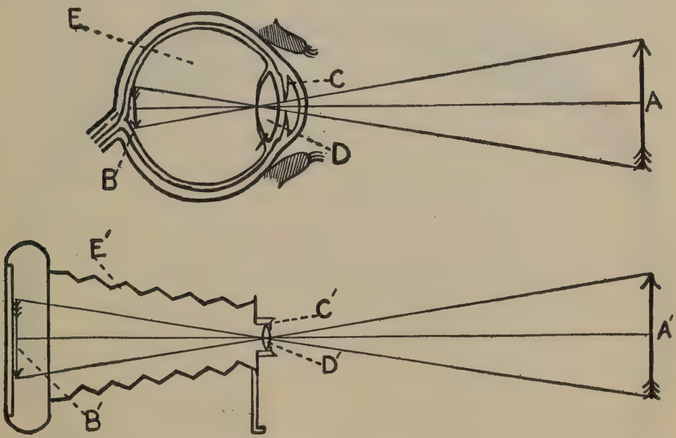


FIG. 18. — THE EYE COMPARED WITH A PHOTOGRAPHIC CAMERA

A, *A′*, the object; *B*, *B′*, the image; *C*, *C′*, the iris or diaphragm; *D*, *D′*, the lens; *E*, *E′*, the dark chamber.

The parts of the eye. — The relation of the various parts of the eye can be best understood by a careful study of Figure 19, a cross section of the human eye. The eyeball is spherical and nearly an inch in diameter. There are three coats to the eye and the eye is filled with a jelly-like substance called the *vitreous humor*. The outer coat is called the *sclerotic*. It is a tough, whitish membrane except in front where it is much thicker but transparent. This front part, through which the light passes, is called the *cornea*.

The second coat, called the *choroid* coat, is dark,

almost black, toward the back of the eye. In front it differs in color with different people from gray to blue, brown, and almost black. This part is called the *iris*.

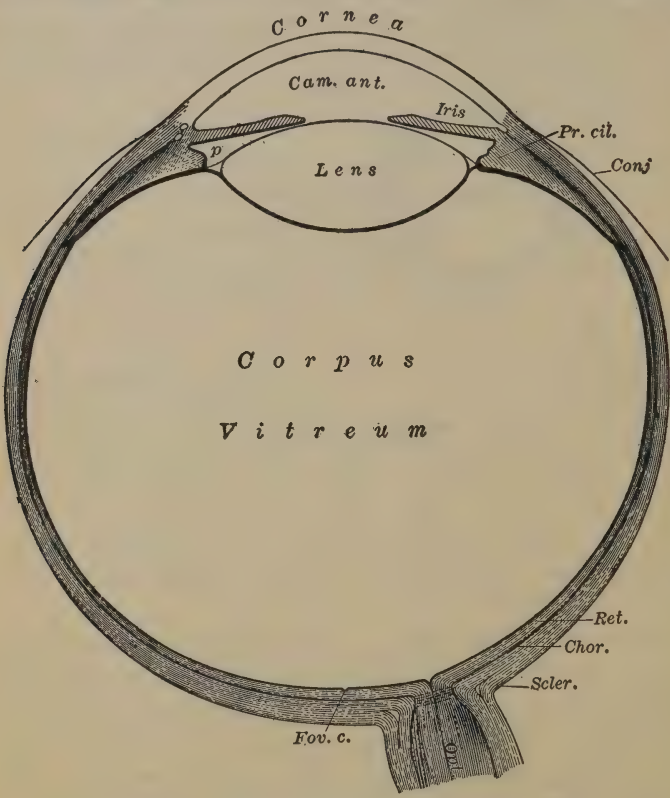


Fig. 19. — Cross Section of the Human Eye

The light entering through the cornea passes through the opening in the *iris* called the *pupil*. The rays are bent (refracted) by the lens so that they are focused upon the retina which corresponds to the sensitive plate or film of the camera. The point on the retina directly behind the lens is the fovea which is the point of clearest vision. Six muscles (not shown in the illustration) attached to the eyeball adjust the eyeball by moving it into such a position that the light rays from the objects are brought to the fovea. (From Carr, *Psychology*, Longmans, Green & Co.)

It is this part that gives the characteristic color to the eye. There is a small hole in the iris through which the light must pass to get into the eye. This opening is called the *pupil* and corresponds to the diaphragm of the camera. Like the diaphragm of the camera it changes in size. When the eye is exposed to bright light the pupil becomes smaller. In dim light the pupil becomes larger. We have already had occasion to refer to this response as the pupillary reflex. The space between the cornea and the iris is filled with a colorless fluid called the *aqueous humor*.

Just back of the pupil is the *lens*. The lens corresponds to the lens of a camera. Its purpose is to bring the rays of light to a focus at the back of the eyeball. The manner in which such a focus is accomplished is shown in Figure 19. Muscles attached around the lens contract to thicken the

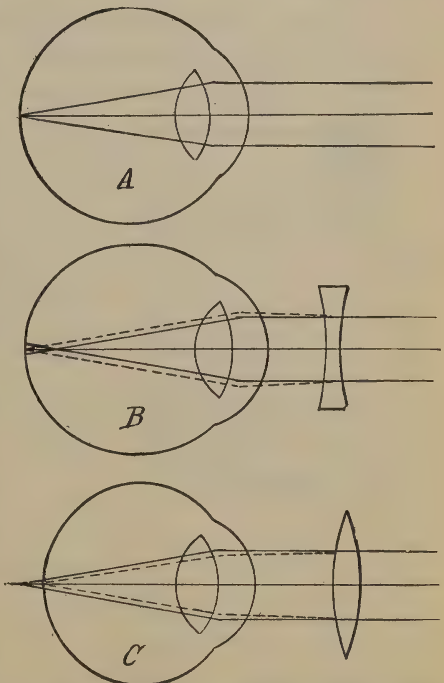


FIG. 20. — DIAGRAM SHOWING HOW LIGHT IS FOCUSED ON RETINA

A. Focusing of parallel rays in a normal eye. *B*. Showing incorrect focus in nearsighted eye with dotted lines indicating correction by concave lens. *C*. Incorrect focus in farsighted eye corrected by convex lens. (From Howell, *Physiology*, W. B. Saunders Company.)

lens when looking at objects near the eye. This adjustment of the thickness of the lens for looking at objects at different distances from the eye is also a reflex response.

In a camera this adjustment for distance is accomplished by changing the distance between the lens and the sensitive film. The distance between the lens and the retina of the eye does not change and does not become a problem except where an individual has an eyeball that is not shaped properly and then he may be either near- or farsighted. These conditions are illustrated in Figure 20. *A* shows the normal eye with parallel rays of light focused on the retina. *B* shows the eye of a nearsighted person where the rays are brought to a focus before they reach the retina. The result is that the person, instead of seeing clearly, has blurred vision. This may be caused, as in the illustration, by too long an eyeball, or it may be caused by too much curvature in the lens for the adjusting muscle to correct. The illustration shows a concave lens used to correct this defect and the dotted lines indicate how the light will then be focused properly. *C* shows the opposite condition, that of farsightedness. The causes of this defect are

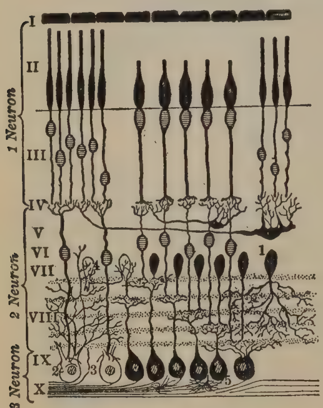


FIG. 21. — CROSS SECTION OF RETINA

The light entering the eye first strikes the part of the retina indicated at the bottom of the diagram. It then passes through the complex mass of cells and fibers, strikes the colored layer shown at the top and is reflected back upon the rods and cones. (From Carr, *Psychology*, Longmans, Green & Co.)

just the reverse of those producing nearsightedness and may be corrected by a convex lens.

The part of the eye which contains the end organs for sight is the retina. The retina is the third coat of the eye and corresponds to the sensitive film of a camera. It covers somewhat more than half of the back part of the

Fig. 22. — Demonstration of the Existence of the Blind Spot

Close the left eye and with the right eye look directly at the cross. Do not let the eye move. Begin by holding the book about five inches from the eye and then gradually move it away. You will find first that the black circle disappears and then as the book gets still farther away the square disappears. (From Breese, *Psychology*, Charles Scribner's Sons.)

eyeball. It contains the rods and cones, which are the sensitive organs for vision. (See Figure 21.) The rods and cones are microscopic in size. The cones are packed closest together almost directly opposite the lens. This is the point of clearest vision and is called the *fovea*. Here the cones are so closely packed together that a pin stuck through the retina at this point would pierce nearly 100,000 of them. There are fewer and fewer cones as we move away from the fovea in any direction, while there are relatively more rods. (The cones are probably the end organs for color vision while the rods are the end organs for brightness.)

These rods and cones are faced away from the lens of the eye. The light passes through the lens, passes through the retina, is brought to a focus, and strikes upon the blackish surface of the choroid coat at the back of the eye. This black coat acts as a mirror and reflects the light rays

backward. As they pass backward toward the lens they strike upon the rods and cones and here set up the chemical action that stimulates the nerve endings. The pathway over which this current passes to the brain is called the *optic nerve.* This nerve begins in the rods and cones. The fibers are all collected in one point near the center of the retina. From this point they break through the three

Fig. 23. — The Blind Spot

Close the left eye. Look fixedly at the cross with the right eye. Move the book back and forth and you will be able to locate a distance to hold it at which the white circle disappears. You see only a large black square. To test the left eye turn the book upside down, close the right eye and fixate on the cross with the left eye. (From Breese, *Psychology*, Charles Scribner's Sons.)

layers of the eye and pass toward the brain. The place where they pass through the retina contains no rods or cones and so is called the *blind spot.*

Ordinarily we are not aware of the fact that there is a blind spot in the eye but we can easily convince ourselves of the fact. Follow carefully the directions under Figures 22 and 23 and prove to yourself that you have one in each eye.

Vision

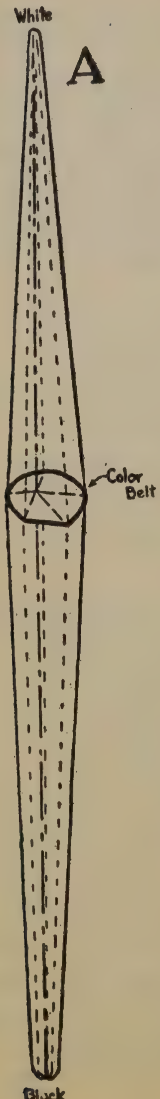
The psychology of vision begins when the physical light waves are changed into nerve currents in the rods and

cones of the retina. These nerve currents are the basis of our sensations of color.

Variations of light waves. — Physicists tell us that light waves are very short vibrations of ether. Ether is that mysterious something which fills all otherwise unfilled space. These light waves vary in three ways: in length, in amplitude, and in form. Different characteristics of vision are related to each of these variations in light waves.

1. *Variations in length.* Light waves are known as transverse waves. That is, they move at right angles to the imaginary line drawn from the eye to the object toward which one may be looking. By length of light wave is meant the distance which the wave moves across at right angles to the line of vision. *It is the difference in wave length that gives us sensations of difference in color or hue.*

These waves are inconceivably tiny. The shortest light wave that we can perceive is 390 millionths of a millimeter in length ($390\mu\mu$) and the longest that we can perceive is about 760 millionths of a millimeter ($760\mu\mu$). In other words, these waves are so small that it would take from 260,000,000 to 500,000,000 of these waves to fill a space the thickness of an ordinary brass pin. The longest waves that we can perceive give us red sensations and the shortest, violet. Other colors from red to violet — orange, yellow, green, and blue — are produced by decreasing wave lengths, intermediate between the red and violet. Most colors that we see are not pure, simple wave lengths, but combinations of different lengths. White, for example, is the most complex and is made up of the combination of all the different wave lengths.



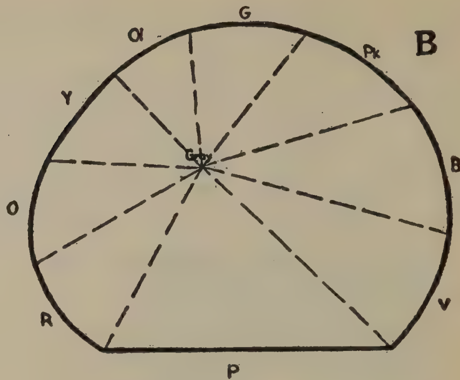


FIG. 24. — COLOR PYRAMID

All variations of hue, saturation, and brightness find their place in this solid. If you pass from the top, marked white, through the core to the bottom, marked black, you get a series of neutral grays varying in brightness. If you go around the outside of the figure, at the point marked "color belt," you get all changes in hue. If you go from the surface to the core you get changes in saturation. (From Warren, *Human Psychology*, Houghton Mifflin Company.)

2. *Variations in amplitude.* — Ether waves vary also as to the amplitude or width of vibration. If the source of light is very intense and is not too far away, the waves will have a wide amplitude or vibration. If the source is weak or very far away, the amplitude will be small. *This change in amplitude gives us changes in the brightness of the color.* A wave of greater amplitude acts upon the sensitive elements of the retina more powerfully than a wave of lesser amplitude. This results in a sen-

sation of greater brightness. These variations in brightness may range all the way from a pure white at one extreme to a pure black at the other.

3. *Light waves vary also as to form.*—Seldom do we see a single wave of light. We see several waves of different length or amplitude combined. This combination gives a variation of form of the total wave. As we have said, white light is a compound of all the different lengths of light waves. *The wave form gives us sensations of saturation.*

The relations of these three variations are best expressed by the double color pyramid shown in Figure 24. Color or hue is indicated by position around the pyramid as shown in *B*. As one goes from the outside surface to the center, one gets changes in saturation, so that at the very core one would find a neutral gray. From top to bottom are shown differences in brightness. Any light one might receive could be placed somewhere in this double pyramid.

Facts of Vision

There are several very important facts to be noted in connection with vision.

Color mixing. — The human eye is capable of distinguishing about 150 different hues. These hues may be thought of as arranged in a band. The more common names of some points on such a band are red, orange, yellow, olive green, blue, and violet. Such a band may be produced by passing a ray of white light through a triangular prism. This prism will bend waves of different lengths to different degrees and thus spread them out into a band. Such a separation of the components of

white light into the different colors by means of a prism is shown in Figure 25.

1. *Colors may be mixed.* — We have seen that we can separate a ray of white light into its component colors. It is possible to mix the different colors of the spectrum (as such a band of separated colors is called) and get white

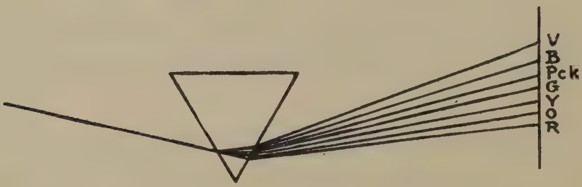


FIG. 25. — MIXED WAVES SEPARATED BY PRISM

The mixed waves as a ray of white light strike the prism on the left. The different component waves being of different wave length are bent (or refracted) differently so that when projected on a screen, to the right, give a band of colors ranging from red (the longest wave) through orange, yellow, green, peacock, blue to violet (the shortest wave). Short waves are bent more than long waves. (From Warren, *Human Psychology*, Houghton Mifflin Company.)

light as a result. This may be accomplished by means of a color wheel, a picture of which is shown in Figure 26. If you use papers on such a color wheel you will probably get gray as a result instead of a pure white. This is because the colors on the papers are not pure colors.

2. *For every color there can be found another color which, when mixed with it, will produce gray.* — Such colors are called *complementary colors.* Mix red with a greenish blue and you will get gray. Mix blue and yellow and you will get gray.

3. *Mix any two colors not complementary and you will get an intermediate hue.* — Mix a red and yellow and the result will be orange. Mix red and violet and you will get purple. Mix blue and green and you will get peacock.

After-images. — There are two types of after-images; positive and negative.

1. *Positive after-images.* — If you look at a bright light and then quickly look toward a dark surface the filaments of the light will be seen for an instant after you look away. This is the positive after-image. Once we receive

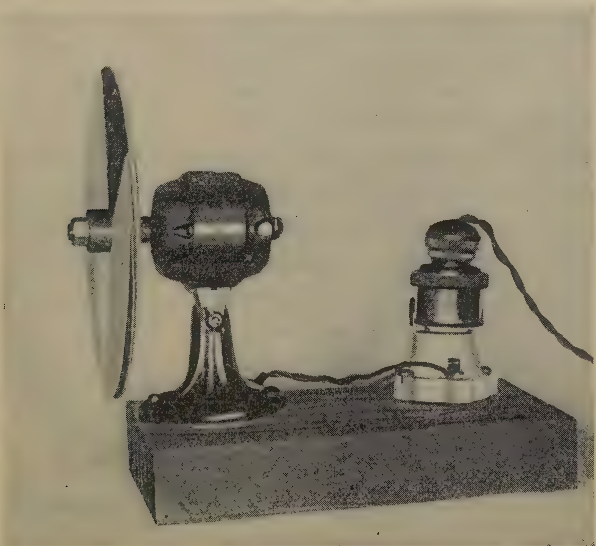


Fig. 26. — Color Wheel

Discs of different hues may be placed on this wheel and when rotated they combine and the observer sees the resultant as a mixture.

a visual impression it takes some little time for it to fade away. The color mixing, spoken about above, depends upon this factor. The colors when rotated on the color wheel are not actually mixed. They stimulate the eye in succession so rapidly, that before one fades out, the other follows and combines with it. Moving pictures operate

upon this principle. One picture is seen and before it can fade away another is snapped in place with just the slightest difference, then another with a little more change. The succession is so rapid (16 a second), and the changes so slight, that we get the impression of movement in the picture.

2. *Negative after-images.* — If you look at some red object, a postage stamp or, still better, a piece of red paper, for ten or fifteen seconds and then look at a white wall or paper, you will see a greenish spot corresponding in shape to the red spot at which you have just looked. This greenish spot will remain for some seconds, especially if the eyes are not moved. Be sure in this experiment that you do not move the eyes while looking at the red object. If instead of a red paper you use a blue paper, when you look at the white background you will see a yellow patch. If you try other colors, you will soon find that you can predict what color the after-image will be. It will be the complementary color of the inducing hue. This complementary color that you see in this experiment is called a *negative after-image.*

The negative after-image is of opposite brightness to the given color. If you look at a bright yellow the blue after-image will be a dark blue. If the inducing yellow is a dark yellow the after-image will be much lighter. Try looking at white paper. You will find that the after-image will be black.

Color contrast. — A very similar fact is brought out when two complementary colors are held close together. We say that the colors clash. They each appear to have more color than when they are apart. A girl with red hair will not wear a green dress or hat unless she is proud

of her red hair, for the green will make the hair look redder. Blue and yellow also clash. This is called *color contrast. The surroundings of a color are tinged with a hue complementary to it.* There is also a contrast effect for brightness as well as hue.

A little experiment will demonstrate color contrast. Take two pieces of colored paper about four inches square, one red and one green and place them side by side. On each of the colored papers place a square inch of gray or white paper. Then cover the whole thing with transparent tissue paper. You will notice that the small pieces of gray paper are not the same. The one on the green background takes on a reddish tinge and the one on the red background takes on a greenish tinge.

Color blindness. — Some men and a few women are color-blind, that is, they can not see all the colors that other people see. There are different degrees and different kinds of color blindness. Most people who are color-blind fail to see red and green and combinations of red and green, but can see other colors. These persons are said to be partially color-blind. They see reds and greens as gray. Of course, since these persons have never seen these colors as a normal person does, they generally do not recognize that they are color-blind. They sometimes can distinguish reds from greens but they do so by other means than by the hues. Sometimes it is brightness that enables them to make this distinction.

The totally color blind are color-blind to yellows and blues as well as to reds and greens. That is, they see all colors only in terms of their brightness. Such persons can get along fairly well under ordinary conditions but they would not make good as railroad engineers, cloth

salesmen, or in any other position in which careful color discrimination is important.

Peripheral vision. — If you look steadfastly at some point directly in front of you and someone holds a pencil or other colored object at your extreme right or left, you can not see it. If the object is gradually moved toward the line of vision, it will eventually reach a point where you can see it but you can not tell what color it is. It will really appear gray, whatever its color. If the object is moved still further toward your line of vision, a point will be reached where you can tell its color. The amount of this movement will depend upon the color of the object. If the object is yellow or blue, it will not have to be brought so near the line of vision as if it is green or red. In other words, all objects in the outside fringe — periphery — of vision appear gray. Further in toward the center of the field of vision blue as well as gray may be seen. Only in the middle of the visual field can all colors be seen. This is known as the *phenomenon of peripheral vision.*

Theories of Vision

What makes the light waves, striking upon the rods and cones, give us sensations of color? We do not know. Several theories have been advanced to explain the facts. The theory that agrees with more of the facts than any other explains the process as due to the breaking down of a photo-chemical substance in the retina.

There is, according to this theory, assumed to be a substance in the eye something like the emulsion of a photographic film or plate. This substance is very easily decomposed by light but it is also continually being built up in the eye. In the lower animals this substance is

relatively simple in structure. When light rays strike the elementary substance, it is broken down and atoms from it set up nervous currents in the rods. The animal probably sees gray when this takes place. The lower animals are not capable of seeing any other than gray. This is similar to the condition of man in total color blindness and in normal persons just at the outside edge of the field of vision.

In higher animals this original color substance in the retina has become more complex. It will still break up into molecules that give gray but these molecules will break up into finer parts. If the rays that break it up are long rays, the animal will see yellow and if they are shorter waves, it will see blue. The higher animals can thus see blacks, whites, yellows, and blues and combinations of these.

In man and some of the other animals the evolution has gone further. The yellow particle is capable, in man, of being broken into two parts, and he gets as a result sensations of red and green. Only the middle portion of the eye of man has gone this far in the process of evolution and this explains why it is only relatively near the middle of the field of vision that he can distinguish reds and greens. Hence man can see whites, blacks, blues, yellows, reds, and greens, and all combinations of these.

There are some facts about vision that this theory does not explain but it does explain fairly well the facts we have given, namely those of color mixing, after-images, contrast, color blindness, and peripheral vision. Since it explains more of the facts and does it better than any other theory that has been advanced, it should be accepted as the best probable explanation until a more satisfactory theory has been devised. If later investi-

gations uphold the theory, it may at some future time be verified and become a law.

QUESTIONS

1. What specific function of the sense organs is implied in the statement that they are the "gateway to the nervous system"?

2. Describe three forms of vibratory energy that affect our sense organs and indicate the limits of our sensitivity to each form.

3. Show how superstition and faulty notions of mental communication may result from misinterpretation of the fact of sensory limitation.

4. What is meant by adjusting to sense impressions? Of what importance is such adjustment?

5. Give a list of the different senses.

6. Compare the eye to a camera, showing the similarity in function of the different parts.

7. Describe the eye, giving the relative position and function of each of the following; sclerotic coat, choroid coat, retina, vitreous humor, cornea, pupil, iris, aqueous humor, lens, rods, cones, fovea, and blind spot.

8. What sort of physical energy gives rise to light sensations?

9. What is meant by a transverse vibration?

10. In what three ways do light waves vary and what sensation difference corresponds to each variation?

11. Show how these variations may be described by a color pyramid.

12. What happens when a ray of light is passed through a triangular prism? What causes a rainbow?

13. State the three laws of color mixing.

14. Explain how the moving picture is dependent upon positive after-images for its operation.

15. What is the negative after-image? What will be the hue of the negative after-image produced by red? By black?

16. What is meant by color blindness? What different forms of color blindness may be found?

17. How does peripheral vision differ from that at the fovea? How could you map out the areas of the retina to indicate the color vision that obtains for the different areas?

18. State the evolutionary theory of color vision.

CHAPTER VI

SENSATIONS (*Continued*)

THE EAR

Hearing is the special sense by means of which we become aware of sound waves. Sound waves are produced by alternate condensation and rarefaction of air particles. Any vibrating body can produce such changes in the air; for example, the string of a violin, the vibrations of a reed, or the membrane of a telephone receiver or talking machine. These vibrations are imparted to

the air, water, or other surrounding medium, and so are transmitted as sound waves.

Parts of the ear. — Hearing is accomplished through a special sense organ designed to receive these sound waves and to convert them into nervous energy. Under ordinary conditions, sound waves enter the auditory canal (See *G* in Figure 27) and strike the ear drum, called the tympanic membrane. (See *T* in Figure 27.) This causes the ear drum to vibrate. This vibration is conducted by means of three tiny bones, called the *ossicles* (*P*), to the opening to the inner ear (*O*). In the inner ear are located the sensitive cells which convert the sound waves into nervous energy.

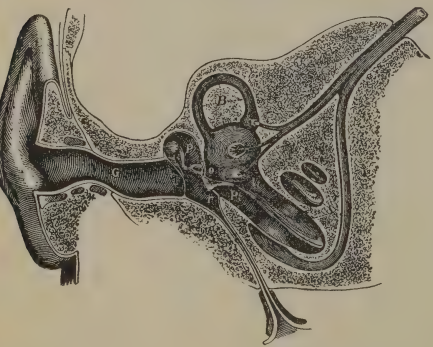


Fig. 27. — Diagram of the Mechanism of the Ear

G. External canal which carries the sound waves into the ear drum; *T*. Tympanic membrane or ear drum; *P*. Middle ear with the ear bones; *O*. Oval window into which the stirrup fits and providing entrance to inner ear; *R*. Round window. (From Howell, *Physiology*, W. B. Saunders Company.)

1. *The external ear.* — The ear lobe that we can see together with the canal or passageway leading to the ear drum comprise the external ear. Its duty is to gather up the sound waves and transmit them to the middle ear.

2. *The middle ear.* — The function of the middle ear is to reduce the amplitude of the sound waves and transmit them to the inner ear. The manner in which this is accomplished can be understood by a careful study of the

diagram in Figure 28. Fastened to the tympanic membrane, or ear drum (*t. m.*), is a bone called the *malleus*, or mallet (*hammer*) (*M*). This is in contact with another tiny bone called the *incus* or *anvil* (*I*). This in turn is in contact with a third bone called the *stapes* or *stirrup* (*S*). The stapes fits into an oval opening which leads into the

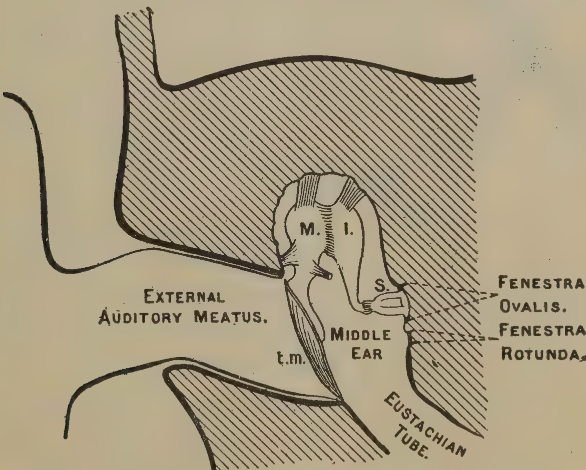


FIG. 28. — SCHEMATIC DRAWING OF MIDDLE EAR

This diagram shows the relative position of the three ear bones or ossicles. They are fastened to the bony cavity of the ear by ligaments. *M*. Malleus or hammer; *I*. Incus or anvil; *S*. Stapes or stirrup; *t. m.* Tympanic Membrane or ear drum. (From Lickley, *Nervous System*, Longmans, Green and Company.)

inner ear. This window is called the *fenestra ovalis*, which is the Latin for *oval window*.

A detailed arrangement of the ossicles (or ear bones) is shown in Figure 29. They are magnified about five times their original size.

Leading from the middle ear is the *Eustachian tube*. It opens into the *pharynx*. This tube serves to keep the

air pressure in the middle ear the same as that outside. Should the air pressure become different it may be equalized by swallowing. The swallowing process opens the Eustachian tube and so connects the middle ear directly with the outside atmosphere. When one has a severe cold, unpleasant feelings often arise in the ear due to inequality of pressure, which can not be corrected, because the tube is closed by the infection.

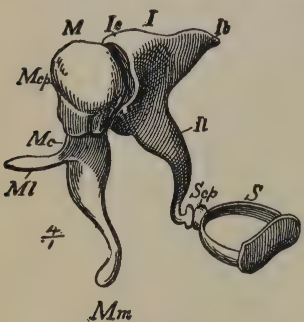


FIG. 29. — BONES OF THE MIDDLE EAR

This diagram shows the ossicles (ear bones) in their natural positions. The bone to the left is the hammer (malleus). Its head fits snugly into a hollow surface on the center bone (incus) or anvil. The long arm of the anvil is in contact with the stirrup (stapes) and the flat part of the stirrup fits into the oval window of the inner ear. (From Howell, *Physiology*, W. B. Saunders Company.)

3. *The inner ear.* — The inner ear has two main parts. One is concerned with hearing and is called the *cochlea*, named from the Latin word for *snail* because it is shaped like a snail. The other has nothing to do with hearing. It is called the *semi-circular canals* and has to do with balancing the body. While it is located in the inner ear it should not be confused with the sense of hearing.

The cochlea is a hollow tube wound two and a half times on itself. It contains what resembles a tiny harp. If unwound the harp would look something like the drawing in Figure 30. It must be remembered, however, that the harp is in the form of a spiral in the ear and that it is also a hollowed-out, bony cavity and not a tube in the real sense.

The sound waves from the stirrup enter the oval window which leads into the space on one side of the harp. The

cochlea is filled with a fluid and the vibrating of this fluid in harmony with movements of the stirrup at the oval window is made possible by the round window being covered by a membrane. When the oval window is pushed in the round window is pushed out, and when the oval window rebounds the round window can move in. These vibratory movements affect the membranes in the cochlea which are set into sympathetic vibration. In turn the nerve cells which are located along the harp of

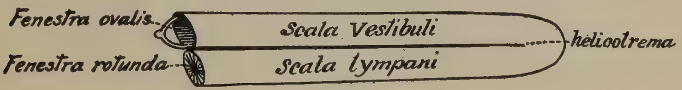


FIG. 30

Schematic figure to show the relative positions of the oval and round windows in the inner ear. This shows how the cochlea would look were it straightened out. It is actually wound in the form of a spiral two and a half times on itself. The sound waves enter the upper or oval window and the round window furnishes an exit into the middle ear. The sensitive hearing mechanism is between the upper and lower sections of the drawing. (From Howell, *Physiology*, W. B. Saunders Company.)

the cochlea take the vibratory movements and translate them into nerve currents.

The auditory mechanism is not adapted to convert every vibration of the air into a nerve current. There are certain requirements for complete reception and conversion.

1. There must be several waves in succession. Usually the succession has a definite rate, so that we can say that the wave oscillates a certain number of times per second.

2. The lowest vibration rate that can be received by the ear and converted into a sensation is about twelve to sixteen, depending upon the individual.

3. The highest rate is somewhere around 40,000 double vibrations per second.

4. Below a certain intensity, air vibrations are not

heard and vibrations above a certain intensity do not produce sound, but a painful sensation in the ears.

Resonance. — We have said that the membrane in the cochlea responds to a sound wave by sympathetic vibration. This is called *resonance.* Let us examine the nature of resonance. Suppose you have a boy sitting on a swing. It can be determined by experiment that, if the distance of the seat from the upper support is kept the same, the time taken for a complete swing is the same regardless of the distance covered in the swinging movement. Let us suppose that the complete movement occupies three seconds. If the swing is at rest, a very weak push will not cause it to swing very far. But, if a weak push is given every three seconds, the effect is cumulative and gradually the amplitude of the swing is increased until the movement may be very great. This is exactly the principle involved in resonance. If a body has a form which gives it a vibration rate of 512 a second, a sound of that rate when it strikes such a body will always strike at the proper time to increase the amplitude of its movement. *A resonator is a body which has a vibration rate which will enable it to respond to a given tone.* A resonator that responds to one tone will not respond to another not tuned to its vibration rate.

This principle has been applied in explaining how we hear. The fibers in the cochlea are supposed to have different vibration rates. A certain sound will cause a certain membrane of the cochlea to vibrate or will cause a combination of cells to vibrate in a specific manner, (psychologists are not agreed as to the precise manner) and the nerve cells, thus stimulated, transmit the energy to the brain cells.

Sound

Variations in sound waves. — Sound waves may vary in three fundamental properties, and there is a definite relation between the physical variations and the resulting sensations.

1. *Sound waves vary in frequency.* — As a result of change in frequency, the pitch of the sound changes. The

Fig. 31. — Tuning Fork

higher the vibration rate the higher the pitch. This can be tested very easily with a tuning fork. (See Figure 31.) A tuning fork has a simple vibration known as a *pendular vibration*, because it swings just like a pendulum or the boy's swing that we used in our last illustration. By attaching a sharp piece of paper to the end of a fork and

holding the tip of the paper against a fast moving smoked drum, it is possible to measure the actual rate of vibration. When this has been done with tuning forks of various vibrations it has been found that high sounds have a higher frequency than low sounds.

2. *Tones of the same pitch may vary in loudness or intensity.* — This is based on the amplitude of the sound waves, and can be tested with a tuning fork. A given tuning fork will always give the same pitch, but the intensity will depend upon how hard you strike it. Strike it a hard blow and the blades will make a wide excursion and the sound will be louder.

3. *The third variation is in timbre or tone quality.* — The underlying physical cause of difference in quality is to

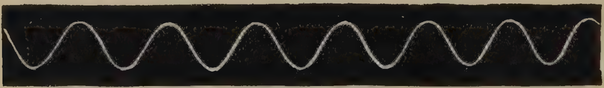


Fig. 32. — Form of Wave Made by a Tuning Fork

be found in the form of the sound wave. (Timbre is a very commonly recognized difference in tones.) Given a certain note of certain intensity from different musical instruments, and the quality or timbre will be different.

It has been found that the forms of sound waves from different musical instruments may be divided into two great groups. The first are the simple or pendular vibrations and the second are the compound or non-pendular forms.

The form of the pendular wave can be easily understood from its name. Its form is that of a simple swinging pendulum or of a tuning fork. If the movements of a tuning fork were written on a piece of smoked paper moved past while it is vibrating, we would get a simple pendular wave as illustrated in Figure 32.

If we had a second tuning fork vibrating at a different rate writing along the same area as our first fork, the result would be a compound wave. This would be a non-pendular wave. It is just such combinations of pendular or simple waves that give us compound waves. In other words each compound wave is made up of a number of simple sound waves. Since the timbre or quality of a

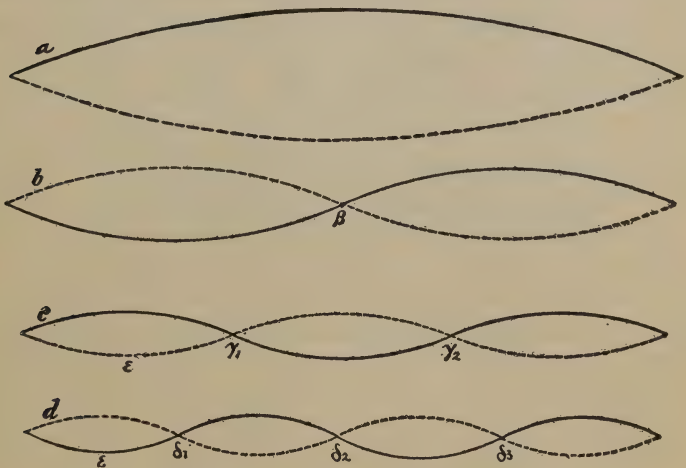


FIG. 33. — FORMATION OF OVERTONES

In *a* the string vibrates as a whole, giving its fundamental tone. In *b*, *c*, and *d* its halves, thirds, and fourths vibrate independently. Combinations of the fundamental with these supplementary partial vibrations is what produces tonal quality of timbre.

tone is a function of the wave form, it follows that the *quality of a tone is the result of the number of blending tones that enter into its composition.* If the contributing tones fit together the timbre is pleasing. If their vibration rates are not so that they blend, we have discord or noise or both combined. Most tones that we hear are not

simple pendular tones but are a combination of different tones blending together.

A study of the way a string vibrates will make the combination of separate tones clear. If we have a string of the same thickness, weight, and tension, the rate of vibration of that string varies with the length of the string. For example, if we have two strings, one half the length of the other, the shorter string will vibrate with twice the frequency of the long string. A string one fourth as long will vibrate four times as fast.

Suppose we have a string that vibrates 128 times a second. The movement of the string will be as represented in the top curve of Figure 33. This vibration of the string as a whole gives its *fundamental tone*. Under most conditions the string will not vibrate in this simple manner, but different sections of the string will vibrate independently at different rates. Each of these independent vibration rates adds another tone to the fundamental. In *B* (Figure 33) is shown the string vibrating in two sections. The rate of these sections will be double that of the entire string, so we will have a tone of 256 vibrations superimposed on the fundamental rate of 128. This is called the *first overtone*. Other overtones are illustrated in *c* and *d*, where the string is vibrating in thirds and fourths. This should make clear the timbre of vibrating bodies. Usually the body vibrates as a whole, but sections vibrate independently, giving other tones in addition to the fundamental. The ways in which a body vibrates depends upon its form, structure, and the manner in which it is struck or caused to vibrate.

The manner in which a string divides and produces overtones is largely the result of the way in which it is

caused to vibrate. It is for this reason that a violinist can make a pleasant note or a harsh note. If his playing causes the string to vibrate in a manner that will produce harmonious overtones, he is a good player. If he does not know how to do this, he creates harsh overtones and the listener does not enjoy his playing. Learning to play a violin is not learning to sound the fundamental tones alone, it is, in addition to this, learning to produce harmonious overtones or tones of pleasing quality.

The production of beats. — Suppose that two tones, differing very little in pitch, are sounded simultaneously.

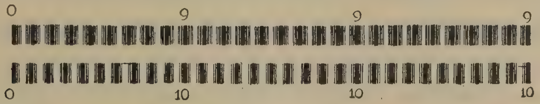


Fig. 34. — Diagram Illustrating the Formation of Beats

The upper line represents the vibrations of a fork beating nine times to every ten vibrations of the fork producing the lower line. Where the points of condensation come together the sound will be intensified. Where the condensation in one line coincides with the rarefaction in the other line the sound will be weakened because one tone will interfere with the other. At the points marked 0 and 10 in the lower line the two tones will reinforce each other and at the fifth beat they will interfere. There will consequently be a beat for each 10 vibrations of the lower fork.

The way in which these two tones combine can be seen from Figure 34. Every stroke in the diagram represents the condensation of the air produced by a single vibration from a tuning fork. The tuning fork above vibrates nine times while the lower one vibrates ten times. Where the points of condensation come together the sound of one will augment the sound from the other. Where the condensation coincides with the rarefaction of the other the two will interfere with each other and the sound will be weaker. At the points marked 0 and 10 in the lower

line the sound will be reinforced and at the fifth beat it will be weakened. This alternation of reinforcement and weakening gives a beat. The beat will occur once in every ten vibrations of the lower fork. The rate at which the beats occur tells how different the two forks are in their rate of vibration.

Now, if two tones are sounded, one of 512 vibrations a second and the other of 513 vibrations a second, once in each second the two tones will reinforce each other and at one point they will interfere with each other. At other times they will be partially between reinforcement and interference. There will then appear once a second a gradual weakening and strengthening of the sound. Such a beat indicates that the two tones are just one vibration a second apart. If one fork vibrates 512 times a second and the second 514 a second there will be two beats a second. If one is 512 and the other 524, there will be twelve beats a second.

Beats are of value in enabling us to tune two instruments together. When they are very nearly in tune it is hard to tell whether they are in tune if they are sounded in succession. If they are sounded together and beats appear, we know that they are different and we can tell just how different they are by the frequency of the beats. If a slight change is made in one instrument and the frequency of the beats increases, we know that we have changed in the wrong direction. If a change in one instrument decreases the frequency of the beats, we know that we have changed in the right direction. Perfectly tuned instruments do not produce beats.

Difference tones. — If we increase the difference between two tones, the frequency of the beats will increase

accordingly. Suppose that we sound one tone of 512 and another of 800. The difference between the two amounts to 288 per second. But 288 changes in intensity are so frequent that instead of being heard as separate swells and falls in intensity they will be heard as a tone. So if we sound two tones of 512 and 800 vibrations together a third tone will be heard, called a difference tone, of 288 vibrations a second.

Suppose you sound two tones an octave apart. One will be twice the vibration rate of the other. If one of the component tones is 512 and the other 256, the difference in vibration rate will be 256. We then have a difference tone of 256 vibrations. But, as this is the same as one of the component tones, the difference tone will not be heard as a separate tone but as a reinforcement of one of the component tones. This is one reason why two tones an octave apart seem to blend so well.

Two tones sounded together may produce another kind of tone higher in pitch than either of the component tones. This higher tone is called a summation tone. Its vibration rate is the sum of the two component tones. For example, if these tones are 256 and 512, respectively, the summation tone will be 768. Neither difference tones nor summation tones may be heard by an untrained listener at first, but a little practice, especially when one knows what to listen for, generally brings them both out.

All these factors that we have mentioned combine to make up the quality of a tone or the form of the tone wave. *Quality or timbre is made up of fundamental tones, overtones, difference tones, and summation tones, all playing their part in creating a very complex wave form.*

Sensations of Smell

The end organs for the sense of smell lie in the upper part of the nasal cavity somewhat removed from the pathway of ordinary air currents. They consist of a small sensitive area in each nostril about 250 square millimeters in size — about the size of a dime.

In quiet breathing the greater part of the air current is conducted to the pharynx directly, and very little reaches the sensitive areas. In full breathing and especially in sniffing, the eddies of the air currents are greater; and so more of the odoriferous substances reach the sensitive parts in the back of the nose beyond the nasal dam. This explains why sniffing helps us to sense odors.

In expiration the breathing passage is so located as to carry nearly all the air past the sensory parts without striking them. Hence, we are not aware of odors in expired air.

It has been found through experiment that much that we consider taste is in reality smell. This can roughly be demonstrated by holding the nose tightly closed while eating. Under such conditions, foods lose much of their enjoyable quality. If carefully done, it is possible to eat a bit of onion with the nose closed and mistake it for a bit of apple. Cheese would most certainly lose its flavor if smell were eliminated.

Some of the odor of foods reaches the sensitive area of the nose by being inhaled before the food is taken into the mouth. Some reaches the sense organs of smell through the opening into the nasal cavity from the pharynx. When food is swallowed, the opening to the nasal cavity is closed by the soft palate, but in the expiration succeeding the swallow, the odor of the food is conveyed to the

nasal cavity. Expiration following a swallow is not a complete one but is accompanied by movements of the pharynx which cause eddies, and so some of the air is drawn over the sensitive area. This can be shown by holding the nose while swallowing. The change in pressure in the nose can readily be felt.

1. *The sense of smell is extremely delicate.*.— This is especially true in some animals, such as the dog. The dog can follow an individual odor with great accuracy and yet the amount of actual olfactory material left on the ground must be exceedingly small. Even in man the delicacy of this sense is almost beyond measure. Attempts to compute its delicacy have been made by taking known amounts of odoriferous substances and diluting them to known extents. Camphor can be perceived when in a dilution of 1 part to 400,000; musk, 1 part to 8,000,000; canillin, 1 part to 10,000,000.

2. *The sense of smell is the oldest sense we have* and has no doubt played a large part in man's adjustment to his environment. It was probably used by primitive man in detecting and testing foods and in protecting himself from noxious surroundings. In accordance with this use, an outstanding characteristic of the sense of smell is the feeling tone that goes with it. Odors are disagreeable, agreeable, or a mixture of the two.

This feeling tone often changes with the intensity of the sensation. A very faint whiff of musk is rather pleasant, but if the amount of stimulus applied is greatly increased the resulting sensation is very unpleasant. The most fragrant perfume if presented in too great volume varies greatly in character and may even produce disgust.

3. *The sense of smell is easily fatigued.* — A continued application of the finest perfume will soon give way to a failure to appreciate it at all. When you first enter a stuffy room you may be very strongly impressed with the unpleasant odors contained therein. Remain there for a few minutes and you are absolutely unaware of their presence. Hence, when you enter a room and see persons calmly oblivious to undesirable odors, do not accuse them of a failure to appreciate the situation. Their sensibilities are just as fine as yours. Stay a while yourself and you will be as blunted to the olfactory situation as they are. Remember, it is the phenomenon of fatigue or, what is called in psychology, *adaptation*, that makes them unaware of the odors.

Combining odors. — The possibility of combining odors to make harmonious combinations, as may be done in the realm of sound or color, is difficult if not impossible. In most cases odors produce a conflict and the resulting sensation is either an alternation between the component odors or the dominating odor may gain the field entirely. Everyone is familiar with the fact that a fish odor or that of an onion will dominate the field. A delicate violet has no chance when competing with an onion.

In other cases two odors seem to neutralize each other. An illustration of this is seen in the fact that the odor of carbolic acid may destroy that of putrefactive processes.

Classification of odors. — It is impossible to classify the different types of odors except by reference to the substances giving rise to the odor. The different odors have been grouped as follows:

1. *Spicy.* These are found in spices such as pepper, cloves, nutmeg, etc.

2. *Flowery.* These are found in flowers as the heliotrope, etc.

3. *Fruity.* These are found in apples, vinegar, etc.

4. *Resinous.* These are found in resins such as turpentine, pine needles, etc.

5. *Foul.* These are found in decaying substances or hydrogen sulphide, etc.

6. *Scorched.* These are found in burned or tarry substances.

Probably the most significant practical fact about odors is that the memory for odors is very persistent and long lived. Once we connect an odor with a particular thing the two are strongly related. The odor recalls the thing and the thing brings back the odor. It is quite likely that in this way many odors gain their undesirable character. For example, a boy was very fond of cheese and liked the odor very much. One day, however, his fondness overcame his discretion and he became very sick from eating too much cheese. From that day forward he could not tolerate the odor of cheese and felt himself becoming nauseated whenever he happened to smell any.

Sensations of Taste

The organs for the sense of taste are called buds and they are located, for the most part, on the upper surface and edges of the tongue. (Some taste buds occur in the soft palate, on the epiglottis, and in the larynx.) If you look at the tongue you will notice that it has a rough or ridged appearance. It is between the ridges of these rough sections that the taste buds are located. The location of the buds may be seen in Figure 35.

In Figure 36 may be seen a single ridge of the tongue

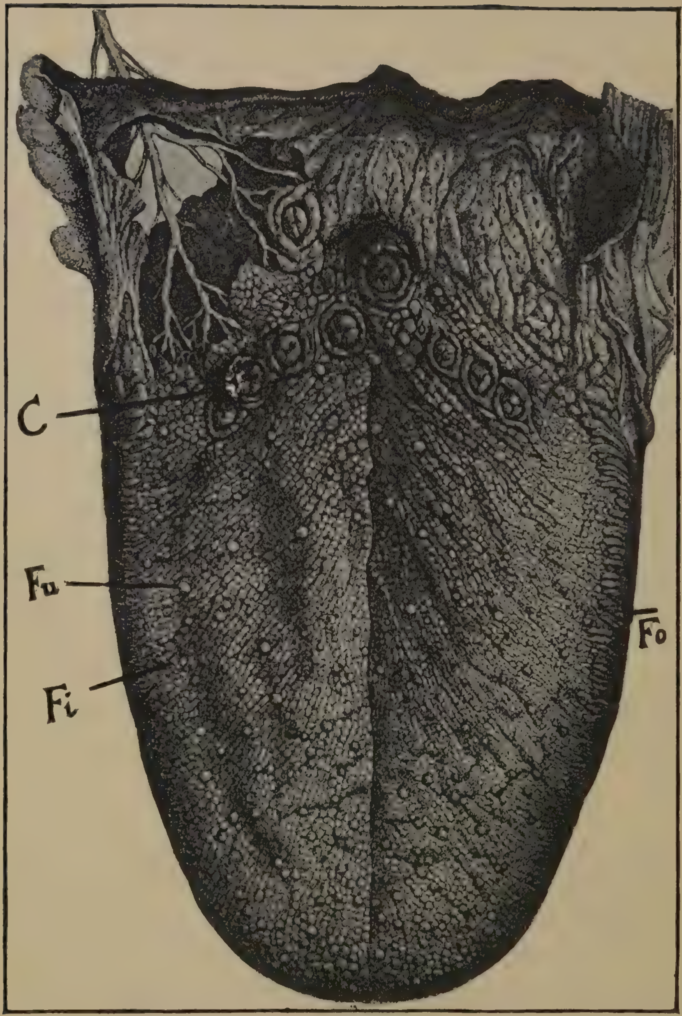


Fig. 35. — Tongue

Taste buds are located in the parts marked *C* and *Fu*. There are none in the ridges marked *Fi* and *Fo*. (From Warren, *Human Psychology*, Houghton Mifflin Company.)

with the taste buds in the trenches on either side. The taste substances must enter one of these trenches in the tongue in order to stimulate a taste bulb. A single taste bud, very much enlarged, is shown in Figure 37.

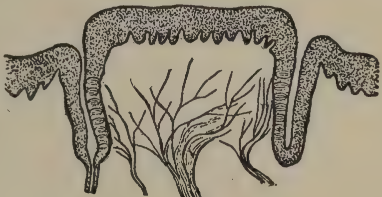


Fig. 36. — Transverse Section through Sensitive Area of Tongue

The taste buds may be seen lining the side of the groove toward the center of the diagram. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

While there are many different variations of tastes, they may be classified into four fundamental sensations; namely, 1. sweet, 2. bitter, 3. salt, and 4. sour. There seems to be a special location for each of these fundamental tastes although there is much overlapping. The base of the tongue is the best location for the sensation of bitter. Sweet and salt can be most easily sensed with the tip of the tongue. Sour can be sensed at several areas but the lateral edges are the most susceptible to sensations of sour. A good way to test this is to place a bit of alum on the tip of the tongue. It will taste sweet. Place it on the back of the tongue and it will taste bitter. If we want to get the full benefit of a sweet morsel of food, we place it on the

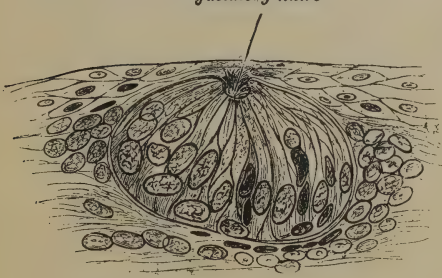


Fig. 37. — Single Taste Bud

Very highly magnified. (From Lickley, *Nervous System*, Longmans, Green & Co.)

tip of our tongue. If we want to take bitter medicine we place it past the back of the tongue.

As we stated above, many of the sensations that we regard as taste are in reality sensations of smell. It is likely that other sensations also come in to complicate the taste sensations. Heat and cold, the texture of foods — their roughness, smoothness, fineness, or coarseness — influence the pleasure we get from eating. Pain is also a factor. Certain foods contain acids which stimulate pain end organs in the mouth.

While we may get much pleasure from eating, we must not think that this pleasure comes from taste alone. All the factors that we have mentioned plus certain æsthetic and social values come in to make our eating a pleasure or a disgusting, unpleasant necessity.

Skin Sensations

Kinds of sense organs in the skin. — The surface of the skin is filled with sense organs. These sense organs are so small that they can not be seen with the naked eye. They are not all of one kind. There are at least four different kinds; ~~touch,~~ pressure, temperature, and pain. A diagram of the four types is shown in Figure 38.

It may seem that there are several more skin sensations such as roughness, smoothness, tickle, itch, moist, and dry. These others are probably only combinations of the four just named. Burning hot is probably a combination of warm, cold, and pain. Extreme cold is a combination of cold and pain. The fact that pain is a common element in burning hot sensations and extreme cold sensations helps to account for the fact that it is so difficult to tell whether a piece of metal or a basin of water is very cold

or very hot if we do not know beforehand which it is and see nothing to indicate its temperature.

Touch and pressure. — If any part of the body is touched we "feel" the pressure. The end organs for pressure are of three kinds. 1. Around each hair are nerve endings. (See Figure 38 *A*.) If the hair is touched a nerve current is aroused. 2. Between the hairs and on the palms of the hands and other parts of the body not covered by hair, there are pressure end organs. (See

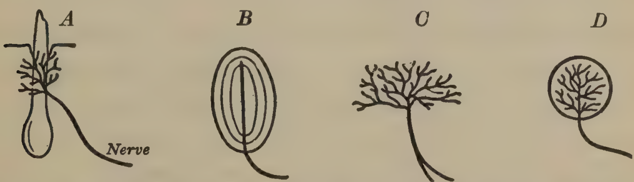


Fig. 38. — Rough Drawings of Four Types of Sense Organs Found in the Skin

(From Gates, *Elementary Psychology*, The Macmillan Company.)

Figure 38 *B*.) These are very numerous in some parts of the body such as the tongue and finger tips. 3. There is a third kind of sense organ for touch located in the deeper parts of the skin. (See Figure 38 *C* and *D*.) These are not so numerous as the others. All three of these types of sense organs give us the same general kind of a "feel."

Even in the same region of the body the fineness with which pressure may be felt differs. This interesting experiment may be performed. Attach some stiff hairs or bristles by wax to the end of a match stick. Select some area on the palm of the hand and press the bristle directly against the skin until the bristle bends. Repeat this several times. If the bristle is not too stiff nor too weak, sometimes the pressure will be felt and sometimes it

will not. Also try the finger tips and some points on the back of the hand not covered with hairs. Next touch lightly one of the hairs of the hand with the bristle. By means of this experiment you will learn that not all areas of the hand have the same sensitivity to pressure. Some points will be found that are more sensitive than others. If you should go over the same areas with a stiffer bristle, you would find that some of the points that did not give a sensation of pressure with the weaker bristle would give one with the stiffer bristle.

Distinguishing two points on the skin. — Closely related to the problem of the sense of pressure is the ability to detect whether one or more than one point on the skin is being touched. Various parts of the body differ greatly in sensitivity to distinguish between a single and a double point. On the finger tips the two points need to be separated but a small fraction of an inch and still the two points are felt as separate points. The hand is more sensitive than the face while on the back the two points may be separated as much as an inch or even sometimes nearly two inches before they can be distinguished as two points. In general the parts of the body used most often in touching objects in our environment are more sensitive than the parts not so used. We explore with our hands but seldom with our backs.

Temperature sensations. — Two other senses located in the skin are so closely related that one is often thought of as the absence of the other. In physics, cold is the absence of heat. But psychologically they are just about as different as any of the other skin stimuli. There are separate sense organs for heat and cold. It often seems as though we feel warm or cold all over the body or

all over the hand. Warm and cold do not seem so much localized as pressure or pain. But the following simple experiment will prove that there are definite areas on the skin that are sensitive to warmth and others that are sensitive to cold.

Warm to about 45–50 degrees Centigrade (130–140 F.) a piece of metal, preferably a stick of brass with one end sharpened, and explore a small area on the back of the hand by touching the point of the metal lightly to successive spots on the skin. Hold the point on the skin about one second and allow at least a second between each touch. At some points you will get a distinct sensation of warmth. At other points you may get a very weak sensation of warmth. At still other points you will get no sensation of warmth, nothing but pressure. Mark with a pen carefully every point where you get a distinct feeling of warmth.

Now cool the piece of metal you have been using to about freezing point (0 Centigrade or 32 F) and in the same way go over the area upon which you have just experimented. This time mark all the spots where you feel cold distinctly. You will probably find that some of the spots are the same and that some are not. You may find that there are more cold spots than warm spots in any area. Some persons have found about ten times as many cold spots as warm spots, but you are not likely to find this great a difference. Before you complete the experiment select a definite cold spot and a definite warm spot. Secure two pieces of metal with sharp points. Heat one and cool the other. Place the warm one on the warm spot and the cold one on the cold spot and see what happens.

Pain sensations. — Pain end organs are the most numerous of any of the skin senses, being about twice as numerous as all the others together. There are few places on the body where pain can not be aroused. At almost any point, even the sharpest needle is sure to strike not one but a number of pain endings. Near and under the finger nails, in the eyelids, and in the pulp of the teeth they are especially numerous. The fewest pain spots are to be found in the cheeks, the thighs, and the ear lobes. A needle can be run through the cheek with relatively little pain.

Instead of being a punishment, pain has been one of man's greatest protectors. There is something wrong with the body when pain occurs. Pain is man's natural danger signal. Neglect of this signal is like crossing a railroad track against the signal — a very dangerous procedure. The physician uses our pains as a basis for diagnosing disease. Through pain man tends to avoid dangerous objects. The author knew a soldier who had lost the sense of pain in one hand as a result of a gunshot wound. The man could move his hand and sense pressure but he could not sense pain. One day he burned his fingers very severely while holding a lighted cigarette because he could not feel the pain of the burn.

Sensations of Balance

In discussing the inner ear we stated that a part of this structure was called the semicircular canals. This organ has nothing to do with hearing but is the organ of equilibrium or balance. Its function can best be understood by learning the precise make-up and location of the different parts.

In each ear the canals are in three distinct parts in the form of horseshoes and are arranged in different planes at right angles to each other. This is shown in the diagram in Figure 39. The two horizontal canals (*E* and *E*) are in the same plane. The superior (*A*) of one side is in a plane parallel to the posterior (*P*) of the other side.

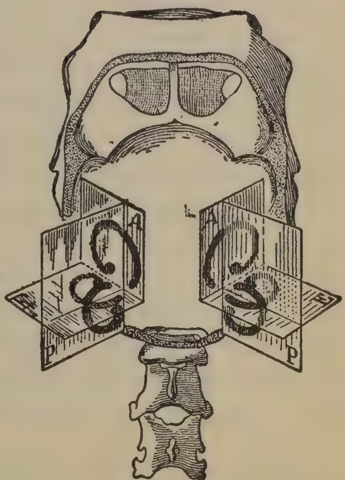


FIG. 39.—THE RELATIVE POSITIONS OF THE SEMICIRCULAR CANALS

On each side it will be seen that the three canals lie in planes at right angles to one another. The horizontal canals (*E*) of the two sides lie in the same plane. The canal marked *A* on one side lies parallel to the canal marked *P* on the other side. (From Howell, *Physiology*, W. B. Saunders Company.)

This position of the canals has led to the formulation of a theory as to their function. They are filled with fluid and at the ends they open into a common chamber filled with sensitive fibers to which the nerves are connected. The theory is based on the assumption that a movement of the head will set up a movement of the fluid in the canals and that this movement will stimulate the fibers. For example, if you have a vessel filled with water and suddenly move the vessel the fluid will set up a wave motion due to the fact that the vessel moved faster than it did. This is the principle of inertia. Now with the canals arranged in all three planes, any movement of the head will set up various currents and the fibrils will be stimulated in different combinations as a result.

Experiments have shown that this theory is valid. When the semicircular canals were removed from animals they were unable to maintain balance.

About the only sensations we get from these organs is a feeling of dizziness. They work without our being aware of their activity. If, however, you spin on your heels several times you will find that you feel dizzy and tend to fall. This is because the violent turning has set the canals into activity and after stopping you must readjust yourself to the fact that they have become active.

The value of these organs became very apparent when aviation was first introduced. It was found that certain individuals have defective semicircular canals and cannot readily maintain their balance when they get away from the ground. Tests have been devised to ascertain the integrity of these organs and have become an integral part of the examination of anyone desiring to go into aviation.

Sensations of Movement and Organic Sensations

These two sensations are very important for our well-being, but for the most part they work without our being aware of their presence. It is only when they become deranged that we notice them. From the point of view of psychology they are not of enough significance for us to spend much time considering them.

They are mentioned, however, so that the student will not get the idea that we have only the five traditional senses.

Sensations of movement. — These are of a very complex nature and are probably a combination of sensations of strain in muscles, sensations of friction at the joints, and sensations of touch and pressure. It is by means of these,

combined with the workings of the semicircular canals, that we are enabled to walk with our eyes closed. We know the location of parts of our body without looking. Have a friend close his eyes, then take his hand and move it into some queer position and he will be able to tell you with great accuracy just how much and where you moved it. It is only where a serious disturbance has interfered with the operation of the nervous system that one loses this ability.

Organic sensations. — These are usually of a vague sort but have a lot to do with our general feeling of well-being, or our feeling of comfort. We can not tell what our stomach is doing from any specific sensations, but after we have eaten a big meal we feel satisfied or stuffily uncomfortable. Hence, whether a person is happy or sad, lively or indolent, is for a large part the result of vague, indefinite organic sensations.

QUESTIONS

1. Describe sound waves and name some of the things which will transmit sound waves.
2. What are the three main divisions of the ear? Describe each.
3. Name the three ossicles in the middle ear.
4. What is the function of the Eustachian tube?
5. What part of the inner ear is not concerned with hearing?
6. Show how a sound wave travels from the external air through the different parts of the ear until it is converted into a nerve current.
7. What are the requirements that are essential before a sound wave may produce a sensation?
8. Explain what is meant by resonance.
9. State the three ways in which sound waves may vary, and relate each to differences in auditory sensations.
10. What sort of a sound wave produces a pendular vibration?
11. Distinguish between fundamental tones and overtones.

12. What is a beat? How is it produced?
13. What is a difference tone? How is it related to a beat?
14. What characteristics of a tone are involved in tone quality?
15. Describe the sense organ of smell.
16. What is the relation between smell and taste?
17. Give evidence to show that smell is a very delicate sense.
18. What is the practical importance of the fatigability of the sense of smell?
19. What happens when two different odors stimulate the sense organ of smell?
20. Give a classification of odors.
21. What can be said about memory for odors?
22. What are the four fundamental tastes?
23. Describe the sense organs for taste. State some facts about the location of the organs sensitive to the different fundamental tastes.
24. What different factors enter into the making of eating a pleasure?
25. What different senses combine to give what we commonly know as touch sensations?
26. Describe the different skin sensations.
27. Why is it that a person with a bad breath never notices the odor himself?
28. Why do onions taste so differently when we have a cold?
29. Why is it that we seldom smell food that is burning until it is badly burned and after we do smell it the odor then appears to be very strong?
30. How does man's sense of smell compare with that of some animals?
31. Compare the time required to fatigue the sense of smell with the time taken to fatigue the sense of vision.
32. What primary tastes as well as what other sensations will be aroused by an ordinary cup of coffee?
33. Why do we often wrap the tongue around a piece of candy while eating it?
34. What is the best way to take bitter medicine so as to avoid as much of the taste as possible?
35. What sensations are aroused by putting the hand into very hot water? Why do we sometimes confuse hot and cold if we cannot tell by some visual cues, such as steam or ice, what the temperature is?

36. Which of the skin senses is least easily fatigued? Why is it important that it should not become fatigued?

37. What parts of the body are most sensitive to touch?

38. Where are the sense organs for the sense of balance?

39. What is the advantage of the arrangement of the planes of the semicircular canals?

40. What changes would take place in the behavior of an individual if the semicircular canals were destroyed?

41. Name some of the organic sensations. What sort of information do they give us about the world outside or the world inside?

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CHAPTER VII

ATTENTION

The Nature of Attention

Life is a continual process of adjusting to the sensations which surround us. Each such situation is a complex affair composed of many parts. To attempt to adjust to all parts in the same degree would cause endless confusion. Hence, we are continually selecting one part as the dominant one and then shifting to another. This process is called attention. *Attention is being keenly alive to some specific factor in our environment.* It is a preparatory adjustment for response.

Attention should not be considered as a force that makes us become alive to one thing to the exclusion of others. Why this process takes place depends upon a number of factors. Attention is simply a name for the process. These other factors will be the center of our

study under the subject of attention, and it should be remembered that improvement of attention means control and improvement of the operation of these factors.

Spontaneous attention. — The newborn baby shows a shift of attention from one element in its life to another. This unlearned process is called spontaneous attention. Its explanation is two-fold.

1. *In the first place his organism is already adapted to respond to certain things more readily than to others.* — Place something against his cheek, and he will turn his head toward that thing and try to get it into his mouth. He pays attention to this touch on the cheek because his nervous system is already organized to enable him to do so. Recite a beautiful poem to the baby and he will pay no attention because he is not born with proper equipment to enable him to do so.

2. *The second factor in the explanation of spontaneous attention is the presence in the environment of a stimulus strong enough to make the individual keenly alive to it.* — The study of attention is then the study of the relationship between certain situations and the make-up of the person who faces them.

When a certain thing gets our attention, it means that it is controlling our reactions to a large extent. Such an item of our experience has a decided advantage over its less fortunate competitors, a fact which we all recognize very clearly. Knowing this, we readily understand that if we could determine just what things should gain our attention and which things should not we could vastly increase our efficiency. An understanding of the laws which govern anything is the first step toward control. If we apply these laws consistently we can improve our

ability to concentrate on the things that are of importance for us.

Controlled attention. — The second form of attention is called *controlled attention. It must be learned.* It is built up on the basis of spontaneous attention, however, and we must learn how to develop controlled attention by a study of the nature of the laws of spontaneous attention.

Phases of attention. — 1. *The natural background of attention is newness.* — Attention arises when something new comes on the scene, something different. This newness makes it attractive, we become keenly alive to it, largely because we do not know the significance of the new item.

2. *The newness factor leads to an exploratory attitude.* — We search for a possible way to react to the new situation. If the solution is easily found the newness passes off and the reaction is made. The thing then no longer makes a bid for attention.

3. *Attention is very mobile.* — It then moves to something else. This is the result of the fact that it is only a response to new things. To find new things means a change from one thing to another continuously.

4. *We are always attending to something.* — Attention shifts rapidly from one thing to another but it never shifts to nothing. To do so would mean that we were out of touch with our surroundings, and this only happens when we have been rendered unconscious by sleep or an anæsthetic. Therefore, never accuse yourself or others of not attending to anything. You may not be attending to the most profitable thing, but you are attending to something. The boy who is sitting in the classroom

"wool-gathering" is attending to his own thoughts. Being keenly alive to them, he is dead to the things around him.

Steps in the development of controlled attention. — 1. *In the beginning stages of attention, the things which gain control must be inherently interesting.* — They must arouse a response of curiosity because they strike a responsive chord. All attention must be built up in this manner. You cannot start with a thing which has no interest appeal.

2. *Things which have no inherent interest of their own can be mingled with the interesting material so that they gain an artificial interest.* — By so doing you can get the two related in the mental life of the individual so that the uninteresting material will call up an interest or attentive reaction. This is the same mechanism that was explained under conditioned reflex.

3. *One may after a time gain the habit of responding to a thing.* — This is the result when one gains the "habit of study." The boy inherently has no interest in study. He will not attend to his lessons. However, through attaching some curiosity to study, he may be induced to study. He realizes that in this way alone he can gratify a curiosity which the teacher (if she is a good teacher) has aroused. He attends as a means to an end. The end is somewhat remote at times and yet he plods along and finally gets the habit of studying material which has no interest in itself. He does it because he has acquired the habit of doing so.

A certain child was incapable of keeping its attention on letters long enough to learn to read. The figures on the page had no interest for him. He was interested in the

pictures in the book. "What do these mean?" he asked his father. "Learn to read and the book will tell you," replied the father. This gave the reading the dominating note in the child's attitude, and he learned to read in order to find out about the pictures. This illustrates how we transfer our attention from interesting things to uninteresting things.

Characteristics of attention. — 1. *Attention is selective.* At any one moment there are a great number of stimuli bombarding our sense organs. There may be different ones affecting the same sense organ. At one time, there may be music in the air, someone talking, and noises entering the room from the street. At the same time stimuli may be affecting us from other sense organs. We may have the toothache and our shoes may be too tight and pinching our feet. The room may be filled with perfume from flowers, the walls may be covered with beautiful pictures, and near us may be the most charming person. All these things make a bid for our attention. The attention process involves a continuous selection from among these diverse stimuli.

2. *Attention is always shifting.* — This characteristic is of utmost importance and should be clearly recognized in any attempt to make attention serve our purposes. Too often persons attempt to "control their attention" and in so doing spend a vast amount of energy trying to keep their attention on a specific thing. We cannot keep our attention on one specific thing for more than eight to ten seconds. Sometimes it fluctuates even more rapidly. Control of attention is not keeping it from shifting but directing its shifting. It will shift, but the next thing to which it will shift can be controlled. When

you are studying or reading a book, your attention is continually moving but the succession of stimuli or points of interest carry it along a definite channel. If the book does not offer such a succession of topics, or if those it does offer do not appeal to you, some outside stimulus will pull your attention away from the book and you will find yourself thinking of something irrelevant.

This shifting of attention can easily be proved. Make a dot on a piece of paper and move away from the paper to a distance so great that the dot will be barely visible. Look fixedly at the dot at this distance and it will be noticed that the dot seems to come and go. Hold a watch at such a distance that its ticking is scarcely audible. As you listen you will observe that the ticks get louder and then seem to disappear altogether. These appearances and disappearances of faint stimuli are indications of the shifting of attention.

3. *Attention at any one moment is limited to a narrow range.* — The very nature of attention makes this so. We defined it as a process, a preparatory adjustment for response. Now the number of things that one can adjust to at the same time can not be great. One can not get ready to begin a race and go to bed at the same time. He can not adjust so as to respond to a hymn and a joke all at once. The same facts that make attention selective make it narrow.

If the different stimuli are somewhat related, one may spread his attention over several at once. If they are essentially different in character, attention to one prevents attention to the other. For example, suppose one is looking at a card on which are some black dots. These are not antagonistic and it may be found that one can

notice accurately in a single instant as many as four or five. This experiment may be performed by having cards with irregularly grouped dots upon them from one to six. Expose each card in turn for the briefest interval and it will be found that when more than four or five dots are exposed one can not say with accuracy how many there were.

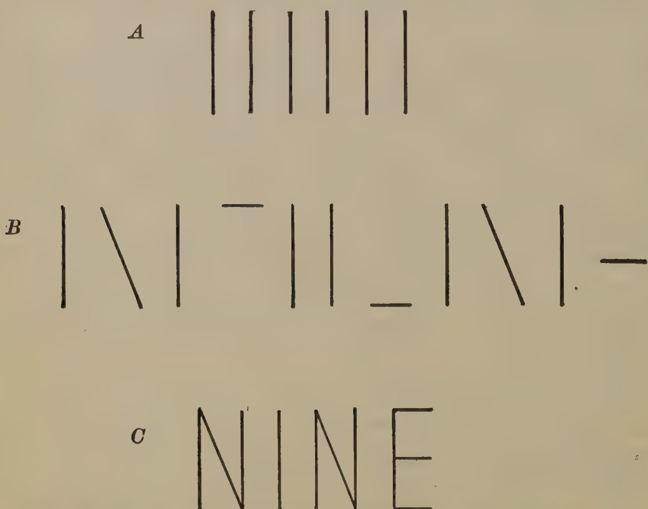

FIG. 40. — DIAGRAM SHOWING HOW MEANING AFFECTS RANGE OF ATTENTION

A. Six parallel lines represent the normal range of attention. *B*. Five lines added make a figure quite beyond the range of attention. *C*. The same eleven lines arranged in a meaningful manner can easily be grasped.

Closely connected with this fact is a principle that will be taken up again under perception; namely, that *meaning enables one to attend to a larger number of items simultaneously.* For example, suppose you had six parallel straight lines arranged as in *A* Figure 40. If they were shown for an instant they would represent about the limit of attention span. Certainly if you were to add

five more to them, as shown in B, you could not apprehend them at one brief glance. If instead you add the five lines so as to give meaning to the whole, as in C, they can be taken in more easily than the original six. The meaning makes you see the eleven lines as a unit NINE. Here you have eleven items, much too many for the ordinary attention span but easily taken in at a single glance because they combine into a meaningful group.

This illustrates very clearly that the number of items one may attend to at a single instant depends largely upon the meaning of those items. One of the best ways to control attention is to harness the facts into meaningful combinations.

4. *Attention increases the clearness of a stimulus.* — Getting ready to respond, means that the stimulus to response takes a leading position in the control of that response. Therefore certain changes take place in our attitude toward a stimulus when we attend to it.

a. Its details become more prominent. Things that might have been ignored on a casual observation stand out and take their place in relation to other circumstances.

b. It assumes a growing importance. This importance increases with continued attention until a reaction finally takes place or until some competing stimulus drives it out. It may become so strong that the final reaction seems to come as a sort of explosion.

c. Judgments about the stimulus become more accurate. Being keenly alive to a stimulus gives it an opportunity to relate itself to other mental facts; such as our memories, other similar experiences, and interests. Then on the basis of numerous connections of this sort, we are better able to interpret the significance of the stimulus.

5. *Attention affects motor adjustments.* — Since attention is preparation, it involves motor preparation. One does not get ready to do a thing solely by thinking about it; one must get set. Motor preparation has various aspects.

a. The sense organs adjust themselves to receive the stimulus more effectively. The head may be turned, the eyes focused and held rigidly on the object.

b. A more rigid control is placed on other adjustments than the particular sense organs involved. Thus, if we hear a sound and attend to it, we may turn our eyes upon the assumed source of the sound. We may knot our brow, may clench our fists, may become rigid, and our breathing may become slower. In other words, we get ready for any occurrence. This indicates that there is a little element of uncertainty in attention. It is a getting ready, but a getting ready for what? If the response follows immediately, the stimulus drops from attention. If the response does not follow, it means that the stimulus has a continued element of uncertainty and the attentive process is designed to enable us to clear up this uncertainty. An illustration is seen in a runner waiting for the signal. His whole body becomes rigid as the time for the expected signal approaches. His attention is due to the fact that he does not know just when the expected "Go!" will come.

c. Rigid resistance is manifested toward any irrelevant stimulus. This is not necessarily due to a conscious effort on the part of the person involved. In fact the most forceful resistances come with no voluntary control whatever. Have you ever watched a child trying to get a dog's attention to make it play, when the dog's attention was

all absorbed in a bone? If the child merely calls, the dog ignores the call, but if the child persists and makes a more drastic bid for the dog's attention, the dog may actively resist the child. He will growl, show his teeth, and fight the child. This analogy gives a fairly true picture of our resistance to competing stimuli that would tend to distract us from an object that has a strong hold on our attention.

Have you ever been in an intense scrimmage where your whole attention was on the game and after it was all over discovered that you had a very painful cut? As long as your attention was wrapped up in the play, it completely debarred the sensations arising in the cut. The cut did not serve as a distraction to the play. But now, after the game, when you tried to study you could not keep your mind on the subject matter, because of the pain from the wound. It was probably no more painful but it occupied your attention because the lesson was not a strong enough stimulus to compete with it. The game was.

Why We Attend

Attention often comes without warning. One finds himself attending without any preliminary intention on his part. Why does he do so? Reasons for attention may be grouped into two main sections; first, the objective reasons (commonly called conditions) for attention and second, the subjective conditions or reasons. The objective conditions have to do with those characteristics of outside situations which make the strongest bid for our adjustment and reactions to them. The subjective reasons have to do with conditions in our mental lives, such as desires,

interests, and impulses which made us tend to choose from among the competing external stimuli.

Objective conditions of attention. — Let us first consider the objective conditions of attention. What characteristics in stimuli make us attend to them?

1. *Change, whether in size or intensity, whether it be increase or decrease, attracts attention.* — A noise may be very annoying at first but let it continue without change and after a while it will cease to be noticed. Let it change in any respect and it will at once attract attention. The change, however, must not be too gradual. The more sudden the change the more likely it will be to arrest the attention. It has been said that it is possible to boil a frog to death without its quivering, if the increase in the temperature of the water is gradual enough. Change the temperature suddenly and the frog would surely jump.

It is very easy to see why change should make a bid for our attention. If everything remains the same, the adjustment or preparation we have already made, suffices. When things change we must readjust our attitude and preparation for response. Remembering our definition of attention as an adjustment process, we can see that this process must keep pace with the changing environment.

2. *Intensity of a stimulus is an important factor in attention.* — The intense sound of a bursting tire, the bright light of electric advertising displays, the strong odor of ammonia, or the sharp pain of a pin-prick will force itself upon our attention. To be sure a very faint stimulus filled with meaning for us may gain attention, even when competing with an intense stimulus, and such situations

are not at all unusual; but, other things being equal, the intense stimulus has the advantage.

3. *Repetition of a stimulus gives it an advantage.* — A speaker may have a trick of speech which may pass unnoticed the first or even the second time he uses it, but if he keeps repeating it, it stands out from the rest of his talk so that the listener's attention is diverted from the trend of thought to this peculiarity. If you tend to ignore the ringing of the alarm clock in the morning, you get an intermittent alarm clock. You may ignore a continuous ringing but you can hardly ignore one that alternately rings and stops.

On the other hand if a stimulus is repeated too often or if it covers too long a period, one gets accustomed to it and it no longer has any attention value. This fact clearly relates repetition to the facts already brought out concerning the effect of change. An oft-repeated stimulus becomes monotonous and so lacks strikingness.

4. *A clear cut stimulus is more effective than a vague, indefinite one.* — A picture with clear cut lines compels attention to itself. One with blurred lines conduces to daydreaming — the mind wanders off to related topics. Sometimes this is considered a factor in favor of an art production since the attention value is not the main end of art. A sharp pain is more likely to be attended to than a dull ache. The same thing holds true of other phases of attention. The reason we can not attend to a lesson, for example, is often that the subject matter is not clear. Our notions are too hazy to lead to clear recognition of their import and so we find ourselves wandering to fields where things are more specific.

5. *Contrast attracts attention.* — A colored picture in a

group of pictures all in black and white will stand out by contrast. Black looks blacker and so more striking when on a white ground. In a block filled with one story bungalows, a three story house would certainly arouse attention. The midget stimulates more attention than hundreds of persons of normal size. Those who desire attention from others usually appreciate this and attempt to be different in some way, sometimes succeeding only at the cost of being ridiculous. They know that they cannot get attention and be the same as everyone else.

Subjective conditions of attention. — The objective factors in attention act as they do because they find our organism ready to respond to them. We are so constituted that our attention is drawn by these factors. Hence, there is a readiness in our nervous systems that might be used to explain all facts so far outlined. In addition there are some other conditions of our mental lives that make attention effective.

Interest stimulates attention. — Interest is the personal meaning that a thing has for us. The boy, interested in the base-ball game scheduled for after school, keeps his attention on the clock. Start a contest in which he will get a reward if he does more work than the other children in the last half hour of the session, and the clock disappears from his attention. The contest has the center of the field. As James said, " Every stir in the wood is for the hunter his game; for the fugitive his pursuers. Every bonnet in the street is momentarily taken by the lover to enshroud the head of his idol." Interested in a thing, we interpret everything in line with that interest.

Interest is a synonym for the sum total of subjective

factors that make us attend. It may take several specific forms.

1. *It may express itself as a simple question.* — Was that sound a gun? Is that shadow a burglar? What is two times nine? Where did I leave my purse? Any question is expressive of an attitude of uncertainty which leads to preparation for solution and of response when a solution is reached. Attention is maintained by a question, until it is answered or until it is superseded by some other attention stimulus.

2. *Interest may express itself as anticipation.* — It is this factor which keeps the boy's attention centered on Christmas. This dominant prospect controls all his thoughts, drives out his studies, makes him interpret all he sees in terms of Christmas, and his conduct is made "good" so that his dominant interests may be realized.

3. *It may express itself as an habitual attitude.* — In the last analysis this is the aim or objective we should have in view in the development of our attentive processes. The boy at first has no interest in the printed characters on the page. They mean nothing to him and so they can not attract his attention. The pictures on the page do attract his attention. He looks at them and, from that interest, the characters next to them derive their attention value. He learns that CAT means the same thing he knows and plays with and whose pictures he has seen. This continues until his whole attitude toward the printed page is changed. He will read and read by the hour, not because the characters have changed the least bit. They have not. He has changed. Nor does he have to know just what pleasure will be derived from every page he reads before he will start. He has learned that the page

probably contains something, so he reads from force of habit and the interest has become a secondary thing. He has cultivated the habit of attending to reading. He has made attention his servant.

How shall we make attention our servant? — We have outlined the process. Let us formulate from what we have said, a few rules for our guidance.

1. *Develop a strong personal interest in the things to which you desire to attend.* — There is a continual competition among the things making a bid for our attention. Interest adds weight and enables the interesting thing to crowd out the uninteresting. Suppose a man can not think of his work because the image of his sweetheart keeps crowding out his work. He can attach his interest in the girl to his work by thinking, "The only way I can gain her favor is to demonstrate my ability in this work. I am doing this for her." Make it worth a pupil's while to study arithmetic and he will go at it zealously. Chide him for his lack of interest and he will probably continue to lack interest.

2. *Control the shifts of attention rather than attempt to keep it from shifting.* — We have seen that one of the characteristics of the adjustment process called attention is change. You can not stop the change but you can keep a continual flow of details of the subject, to which you desire to attend, before you and thus crowd out other things.

3. *Doing things helps attention.* — One can not forever adjust without activity. Adjustment (which is a synonym for attention) should prepare one to act and then he should act. Attention means a problem at hand. Meet that problem and another one in the same field

will soon come to the front. Direct your energy toward solving your problems and attention will follow naturally.

4. *Never try to fight distractions.* — Distractions will lose their force automatically when you get absorbed in something else. A conscious attempt to ward off a distracting stimulus keeps it in the foreground. The following story illustrates this. A man taking a room in a hotel was told by the clerk that he should be very quiet for the man in the room below him was very nervous. As he prepared for bed he momentarily forgot the injunction and dropped one shoe on the floor with a thump. The sound of the shoe hitting the floor reminded him of the man below so he was careful to make no noise with the second shoe. An hour later he was awakened by a knock at the door. "What is it?" he called. He was greeted with this reply, "Say, drop that other shoe so that I can go to sleep." This man had tried his best to keep his attention from the expected thud of the second shoe. Trying to forget it only made it worse and he finally decided that the only way to get his mind at rest was to get the man to drop it.

5. *Make attention a habit.* — This means that when we are absorbed in our work, attention as an entity never comes to our notice. After one learns such a motor habit as writing on a typewriter he is not continually asking himself, "Now am I doing this right?" The process is automatic and the end in view — getting the material on the paper — is the dominant thing. Attention is a process to be used for a definite purpose, but the purpose will be defeated, if all you see is the process.

QUESTIONS

1. Define attention.

2. Name the two forms of attention. State clearly the difference between them and give an example of each form.

3. What two sets of facts are needed to explain spontaneous attention?

4. Name four phases of attention which indicate that attention is a process.

5. Illustrate each of the steps involved in the development of controlled attention.

6. What characteristic of attention is illustrated by the fact that we never see everything in a show window? What do we generally notice? Explain.

7. Turn to Figure 57 in this text. Sometimes you can see six and sometimes seven blocks. What characteristic of attention does this illustrate?

8. Select some illustrations from your life to show that attention is narrow in range.

9. What effect has meaning on the range of attention?

10. Explain the effect of attention upon a sensory stimulus.

11. Find illustrations of the three ways in which attention affects motor adjustments.

12. Why is it that we often do not hear a attle or knock in a car until someone tells us about it, after which we can not keep ourselves from listening to it?

13. Illustrate each of the objective conditions from the field of advertising. You might do this by collecting a series of advertisements, each one illustrating one of these objective conditions of attention.

14. What are the subjective conditions of attention?

15. Give four rules for the training of attention. Try to find experiences from your own life that illustrate the truth of each of these rules.

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CHAPTER VIII

PERCEPTION

Nature of Perception.
- Unifying experience

Illusion.
- Under certain circumstances sensory experience is apt to be misinterpreted

Interpretation.
- The thing seen sometimes modified by expectation
- Hallucination

Perception of Visual Space.
- One dimensional space
- Two dimensional space

Perception of Distance.
- Monocular factors
- Binocular factors

Perception of Auditory Space.
- Ability to determine source of a sound very inaccurate

Perception of Time.

Perception in Reading.

Nature of Perception

The thing that we see is often quite different from the sensation that strikes our sense organ. This is because we interpret our sensations, we read meaning into them. If we hear a noise it may at first merely arouse a question in us, " What was that? " We are not satisfied with the answer, " It was a sound." We want to know the significance of the sound. If finally we are told that it was a car back-firing we are satisfied.

Suppose a newborn baby heard the same sound. He would probably start because of the sound, but the sound would have no significance for him. He has not learned about back-firing and so the sound would die, a mere meaningless experience. We say that the child will learn the meaning of such sounds later on. This shows that a large part of our development is learning to understand the significance of the things we experience. It is only as we learn to interpret things, to read meaning into them, that we grow mentally.

Let us see how a child learns to do this. Suppose he is given an orange. He has had no experience with an orange before, so he becomes acquainted with it through a series of sensory impressions. It is important to keep this clearly in mind. All the information he receives must come through his sense organs. He holds the orange and gets touch sensations from it. He looks at it and he gets certain sensations of color and form. He puts it in his mouth and in doing so he gets certain smell sensations. If he bites it he gets taste sensations. If he explores further and breaks it open, he may get more visual and touch sensations. A drop of the juice may shoot into his eye and result in a pain sensation. All these combine to form his actual information about an orange. Further, he may be told something about where oranges grow and other facts about them that he could not get very well at first hand. These are also added to what he has learned through sensory experiences resulting from manipulation.

An important factor in mental life is to unify experiences. — Consequently all these different facts about an orange tend to unite in a very definite manner. Asked the question, " What is an orange? " all that has been

learned in this manner will be brought together in formulating his answer.

But, another very important consequence comes from this mental combining process. When we see, hear, feel, smell, or taste anything it fits itself into what has already been learned. Suppose you turn your eyes toward an orange lying on a table, what sensations reach you? You get a visual impression of a colored circle, but you say the orange is round and solid, not flat. You know that because you have learned it before. Hence, when a

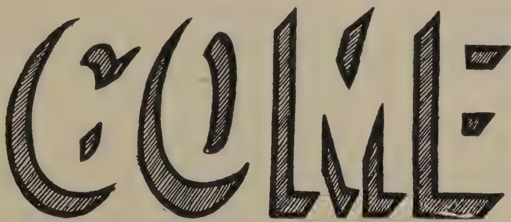

FIG. 41. — FILLED-IN PERCEPTION

Hold the book at arm's length and the letters will appear to be solid. If the solidity does not appear at once tip the book slightly. (From Warren, *Human Psychology*, Houghton Mifflin Company.)

stimulus strikes our sense organs it is a cue which we immediately interpret in terms of our past experience. We do not need to go up to the orange, pick it up and feel it, taste it, smell it, and tear it to pieces to interpret it as an orange. Our lives would be a tedious bore if we had to keep repeating these processes all the time. We save time by accepting the cue for the whole thing.

This immediate interpretation of a sense impression is called a *perception*. — When you say, "I perceive an orange," you mean that you have a few impressions which act as cues and to these you add your past experiences and interpret these cues as evidence that an orange is

present. Sometimes we become so sure of our cues, that we think that we are experiencing the whole thing; sometimes our cues are not certain and so we doubt what this thing is that we are experiencing. Sometimes we interpret our cues differently from another person next to us and so we see the universe in a different manner from him. All these things are perfectly natural, however. We should not chide ourselves because we cannot interpret every experience at once; nor should we worry because someone else gets an interpretation different from ours. It is because we make mistakes in interpretation and because we differ from others, that we learn. These differences are the most valuable experiences that we can have.

The use of cues as indicators of a complete impression is very marked in the visual field. We are continually seeing bits of things and responding as though we had experienced an object in its entirety. Figure 41 shows this. Here the letters are omitted and only the shading is shown on the page. Hold the illustration at arm's length and you will interpret it as though the complete letters were there.

Figure 42 illustrates the same thing. The man's trousers are not shown at all but we " see " them very clearly. In the picture there is a dotted line but we " see " the woman's skirt draped over her knee.

Woodworth gives some good illustrations of using a cue for the whole thing. " We look out of the window and ' see it is wet to-day,' though wetness is something to be felt rather than seen; having previously observed how wet ground looks, we now respond promptly to the visual appearance by knowing the indicated state of affairs.

In the same way, we say that we 'hear the street car,' though a street car, we must admit, is not essentially a noise. Strictly speaking what we hear is a noise, but we respond to the noise by perceiving the presence of the car. Responding to a stimulus presented to one sense by perceiving a fact which could only be directly presented to

FIG. 42. — FILLED-IN PERCEPTION

The marks on the picture are interpreted. We do not "see" parts of shoes balanced on a black mark. We interpret them as two feet fastened upon two real legs. Other parts of the picture are interpreted in the same manner. (From Hollingworth, *Advertising and Selling*, D. Appleton and Company.)

another sense is exemplified also by such common expressions as that the stone 'looks heavy,' or that the bell 'sounds cracked.'"

All this goes to show that we read meaning into the things that strike our sense organs. In other words, we *perceive* those things. As Woodworth states it: "We see things not as they are but as we are."

Illusions

Under certain circumstances we all tend to misinterpret certain sensory experiences. — If we are possessed with the idea that our impressions are faultless, a little study of illusions will get us over our vain conceit. Let us study a few.

1. *Vertical distances are perceived as greater than mathematically equal horizontal distances.* — This is clearly seen in Figures 43 and 44. The vertical line in Figure 43 looks longer than the horizontal one upon which it is standing. Measure them and you will find them the same. You can test this for yourself by drawing a horizontal line and then attempting to draw a vertical line adjacent to it of the same length. After you have done your best to make them the same, measure them. You will find that the vertical one is invariably shorter. If you make them the same length, the vertical one will look longer than the horizontal one. Figure 44 shows the practical implication of this principle. A high hat will look higher than it really is on account of this illu-

Fig. 43. — Vertical Horizontal Illusion

The two lines are the same length, although the vertical appears to be much longer than the horizontal. (From Robinson and Robinson, *Readings in General Psychology*, University of Chicago Press.)

sion. In Figure 44 the height of the hat is the same as the width of the brim although it looks much higher.

2. *Filled or divided space appears greater than empty or undivided space.* — This is illustrated in Figure 45. At *a* we have the space to the left divided by a number of vertical lines. This section looks longer than the equal empty space to the right. In *b* the divisions are finer but still the divided space looks longer than the undivided. The illusion is not so marked in *c* where the space is filled by solid black but it is still present. If you are not convinced by looking at Figure 45 that this illusion is present, make a heavy black line about an inch to an inch and a half long and then try to mark off a point to one side which represents a distance equal to the length of the line. Measure the accuracy of your estimate.

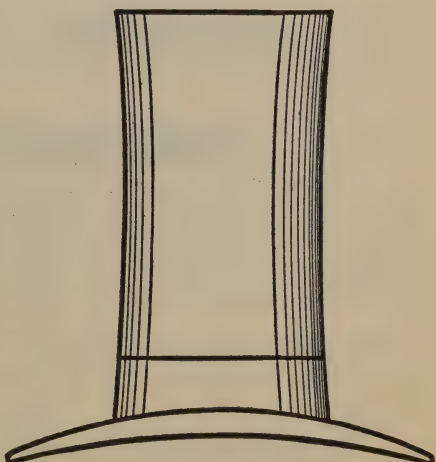

FIG. 44. — VERTICAL HORIZONTAL ILLUSION HAS A PRACTICAL BEARING

The hat is just as high as the brim is wide. It looks much higher. (From Robinson and Robinson, *Readings in General Psychology*, University of Chicago Press.)

3. *Contrast affects our interpretation of sensations.* — This works in many fields. We have already seen how contrast affects our interpretation of colors. We know how sour vinegar tastes after eating sugar. A disappointment is keener if we have been keyed to a high

pitch of expectancy. Bliss is greater if we have been somewhat despondent. Contrast affects all our interpretations.

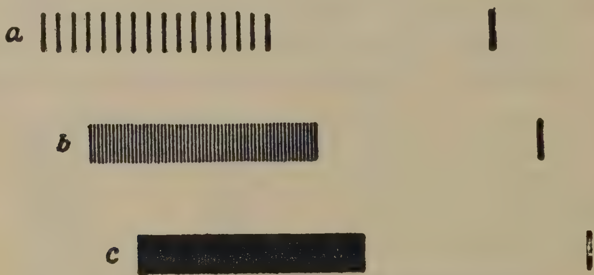

Fig. 45. — Illusion of Filled and Empty Space

Divided and filled space appears greater than empty or undivided space. Cover the lines to the right with a piece of paper that does not permit the lines to show through. Then mark off a distance equal to the divided or filled section. By measuring, see how nearly correct you have estimated. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

This illusion is shown clearly in the visual field as may be seen in Figure 46. The distance between the arrow

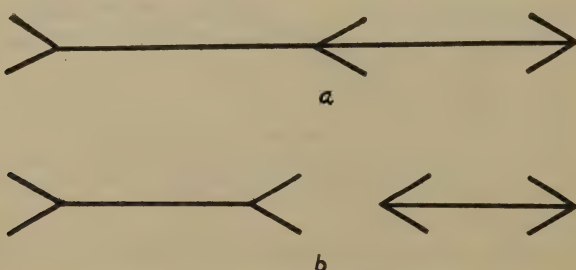

Fig. 46. — The Müller-Lyer Illusion

The distance between the arrow points is the same in each case. Even after you measure with a ruler and convince yourself of this fact the distances still look different. (From Robinson and Robinson, *Readings in General Psychology*, University of Chicago Press.)

points to the left is the same as the distance to the right, but they certainly do not look the same even after you

have taken a ruler and convinced yourself of the fact. This is called the Müller-Lyer Illusion.

In Figure 47 the middle section of each line is the same length. The lines adjacent to the middle section make

FIG. 47. — EFFECT OF CONTRAST

The middle segment of each line is the same length. The one to the right looks smaller. This is due to the contrast effect of the adjacent lines. (From Robinson and Robinson, *Readings in General Psychology*, University of Chicago Press.)

them appear different. The middle section to the left looks longer than the middle section of the right line. A midget looks even smaller when in the company of giants.

In Figure 48 the distance from the fulcrum to each of the squares is the same. But the distance from the ful-

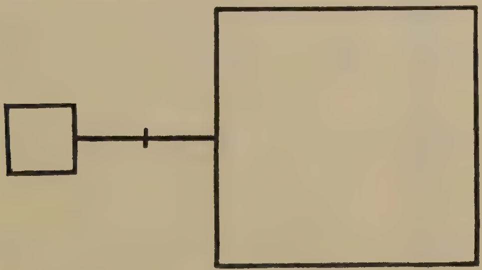

FIG. 48. — EFFECT OF CONTRAST

The distance from the fulcrum to each square is the same. The distance from the fulcrum to the large square appears smaller than the distance to the small square. (From Robinson and Robinson, *Readings in General Psychology*, University of Chicago Press.)

crum to the large square looks much shorter than that between the small square and the fulcrum. When adjacent to a large object, a stimulus appears smaller than it is, and when adjacent to a small object, it appears larger than it is.

4. *The apparent direction of a line is influenced by the presence of other lines.* — Figure 49 presents three illustra-

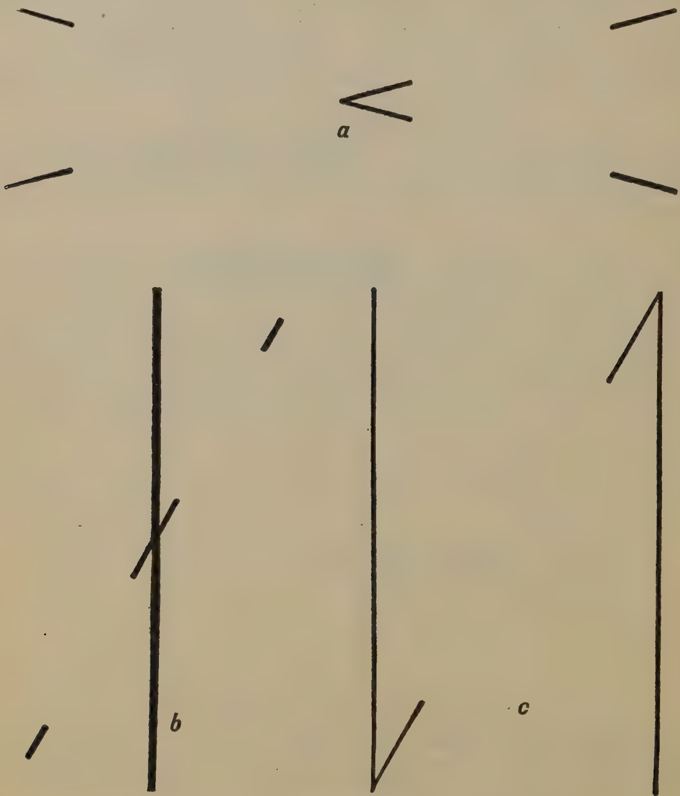

FIG. 49. — THE ANGLE ILLUSION

In each case the broken lines if connected will be found to form straight lines. The apparent direction is different from the actual direction. See the text for explanation. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

tions of this illusion. In *a* it looks as though the junction of the lines to the left, if they were extended, would fall

to the right of the junction of the two short lines in the center. It also appears that the junction of the lines to the right, if they were extended, would fall to the left of

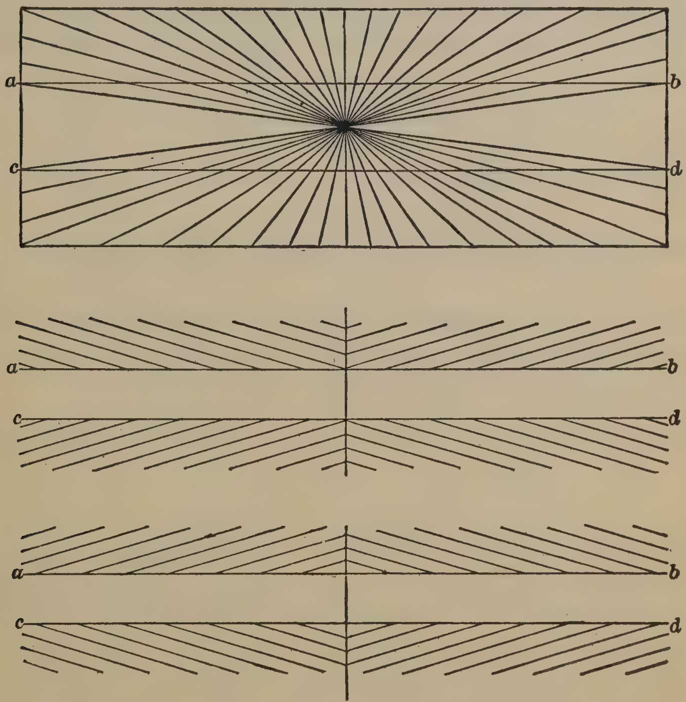

FIG. 50. — EXTENSION OF THE ANGLE ILLUSION

Place a ruler on the horizontal lines and you will find that they are not curved or bent lines as they appear. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

the junction of the center lines. Place a ruler on them and you will find that this is not the case.

In *b* the three sections of broken line if connected would form a straight line. The same thing is true of the two short lines in *c*. A general rule that applies here is that

acute angles seem to be overestimated and obtuse angles seem to be underestimated. Apply this rule to each of the figures and it will explain the apparent discrepancy.

A further application of this rule gives the illusions in Figure 50. Here the horizontal lines are all straight and

Fig. 51. — Illusion of Area

The areas are all the same but they do not appear to be so. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

parallel but they appear to be bent. A misinterpretation of the angles in accordance with our principle will account for the apparent bending of the horizontal lines.

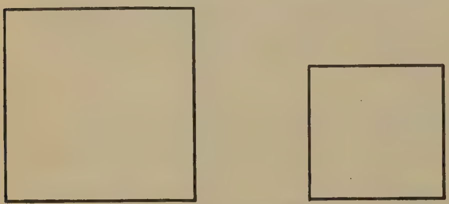

Fig. 52. — Judgment of Areas

One square is twice the area of the other but one would not judge the difference between them to be so great.

5. *Illusions of area.* — The areas in Figure 51 are all approximately equal but they look different. A rule that seems to apply here is that *compactness of form seems to diminish the apparent area of the surface.* Our judgments of area are very uncertain. In Figure 52 are two squares one twice the area of the other. One would not guess without calculation that they bear the ratio of 1 to 2.

Another illusion that comes in the interpretation of area is seen in Figure 53. If one figure is superimposed upon the other it will be found that the two areas are the

same. Trace them on a separate paper, cut them out, and prove it for yourself. In the illustration the lower one certainly appears to be the larger. This figure, however, probably offers a complication of the effect of contrast with the inability to judge areas. The long side

FIG. 53. — ILLUSION OF AREA

Both of these figures are the same. The illusion of area is probably complicated with the illusion of contrast. The long side of one figure being adjacent to the short side of the other makes the latter look shorter by contrast. (From Ladd and Woodworth, *Physiological Psychology*, Charles Scribner's Sons.)

being placed adjacent to the short side of the other figure makes the latter look shorter by contrast.

6. *Illusions of perspective.* — In Figure 54 the converging lines suggest perspective. The reason for this probably lies in the fact that as parallel lines recede from us they seem to converge and hence when we see converging lines we interpret them as representing distance. Everyone is familiar with the way the two rails of a track seem to come together at a distance. In Figure 54 we have blocks of equal size, as measured by a ruler, but

which appear larger as they seem to be farther and farther away from us. We may conclude from this that apparent distance is a factor in our judgment of size.

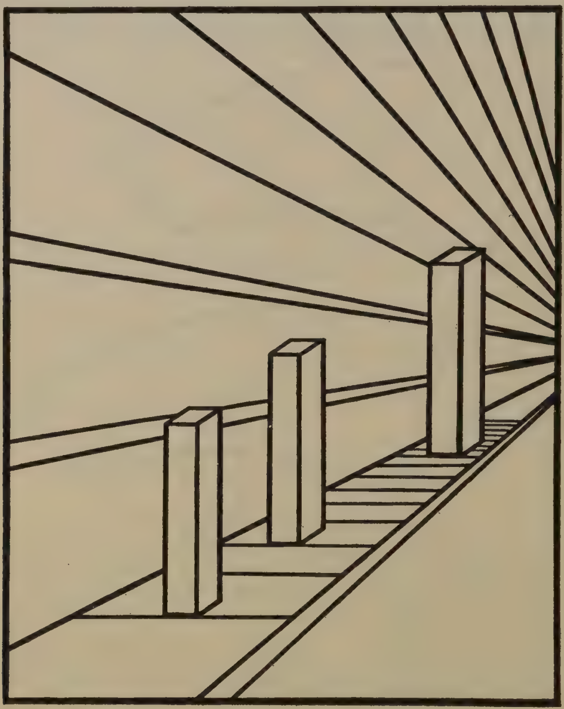

FIG. 54. — ILLUSION OF PERSPECTIVE

The blocks are all the same size. The converging lines make them appear to be at different distances and the farther ones therefore appear to be much larger. (From Robinson and Robinson, *Readings in General Psychology*, University of Chicago Press.)

This type of illusion is still more strikingly brought out in Figure 55. Measure with a ruler and you will find that the man and the boy are of exactly the same height. What you should see is an overgrown boy standing behind

a diminutive man. Due to the fact that the converging lines make the man appear to be farther away, we see him as a giant and the boy as a tiny fellow.

These illusions are known as normal illusions, because they are common to all of us. The question arises in our minds, "If our perception of objects is so likely to be erroneous, how are we to know when to trust our senses?" The answer is to be found in the means we have taken in all these illusions to convince ourselves that they were illusions. They looked to be one thing; and with no additional evidence we would have been compelled to believe our first impressions. When we checked these impressions with evidence from other sense fields or with other controlled observations (as by measuring with a ruler), we found our first impressions to be wrong. The test as to the verity of any interpretation comes from checking it with impressions from the same or from other sense fields.

Fig. 55. — Illusion of Perspective

The man and the boy are of one height. When a boy is as tall as a man he should appear overgrown. The man here looks like a giant and the boy like a pigmy.

In other words our *perception is a following out of the scientific procedure* outlined in the first chapter. We experience a sensation. It is a bit of information that we must interpret. Our interpretation is an hypothesis or theory. We may be satisfied with this interpretation and go on our way, or we may check up with other bits of information at once. When contradictory information comes to us, we must adjust the discrepancy in some manner. Mental integration begins in perception; and one must harmonize his sensory impressions into consistent perceptions if he is going to achieve mental unity.

What is to be done when they will not harmonize? That is the case in these persistent, normal illusions that we have just been describing. In such cases one admits that his visual impression is wrong and takes the result of his measurement and experimental checking of the facts. This experience then teaches him that when he encounters vertical and horizontal lines, for example, he can not trust his visual impression alone. He will not give an opinion until he has checked up with a ruler. These illusions teach us that the old adage that "Seeing is believing" is wrong. Seeing should not always be believing. We should form hypotheses on the basis of what we see and withhold belief until we get corroborative evidence.

Interpretation

It is possible to perceive the same situation in different ways. — For example look at the illustration in Figure 56. What do you first see? There are just so many lines on the page but you may interpret them as a staircase. Look at the illustration fixedly and it may turn into a picture of the under side of a staircase. Or, you may have

seen the under side first. If you did, it may turn as you look to the upper view. Certainly, the stimulus was the same no matter which way you interpreted it.

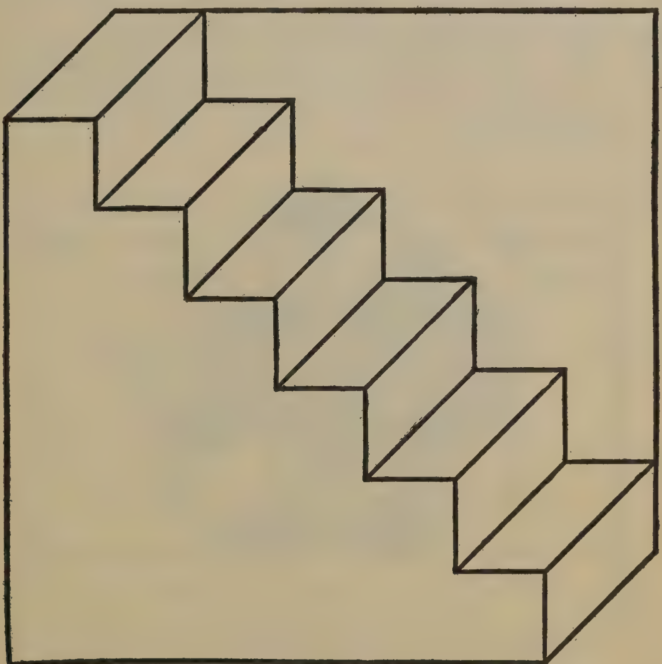

Fig. 56. — Staircase Figure

The diagram may be seen as the top view of a staircase or the under view of a staircase. The central part may look like the side of an accordion with first one side close to the observer and then the other side. (From Carr, *Psychology*, Longmans, Green & Co.)

Now, look at it again and see whether you can not see the central part as a strip of material folded as in an accordion. As you look for this you will see it as such. Again, you can see this accordion change so that at one time one line seems to be a near fold and then it will

change and appear to be a remote fold. After you have seen the diagram as these four things — that is, a staircase from two angles and an accordion from two angles — look at it fixedly and you will find that it will change repeatedly from one to the other with no effort on your part. You may be able to retain one view more persistently than another if you try but you are likely to find the others creeping in.

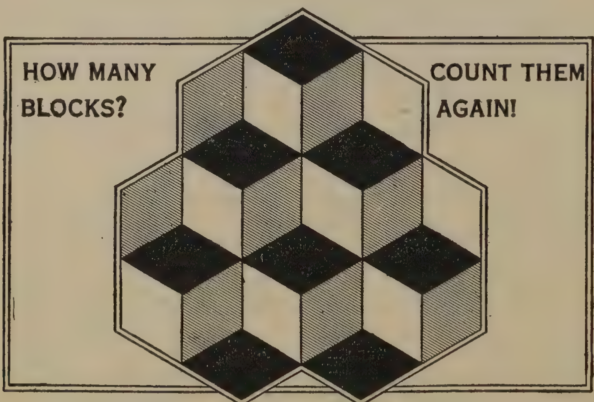

FIG. 57. — AN AMBIGUOUS FIGURE

This figure may be perceived as either six or seven cubes. How many do you see? (From Carr, *Psychology*, Longmans, Green & Co.)

The same sort of double interpretation may be found in the cube drawing in Figure 57. After you once see six cubes it is hard to get rid of that view. Or if you have seen seven it may be hard to get rid of that view. Sometimes the views shift with no apparent reason and without effort on our part.

A different sort of double interpretation is illustrated in Figure 58. One can see a rabbit or a duck with equal readiness.

In all these cases we are as willing to see one thing as the other. Each interpretation is as readily accepted as another and so they come and go with great ease. Later on we will find that what we see is influenced by what we want to see. As this is a form of expectation we may understand this element by seeing how expectation affects interpretation.

FIG. 58. — RABBIT DUCK FIGURE

One may interpret this picture either as a rabbit or a duck. (Jastrow's figure from Warren, *Human Psychology*, Houghton, Mifflin Company).

The thing one will see can be modified by expectation. — Suppose you say to a friend of yours as you open this book, " I am going to show you a duck." The chances are that he will see a duck in Figure 58. He might not see the rabbit at all. Or you could predispose him in favor of the rabbit by the position in which you hold the

picture. Hold the ears erect and they will not at first look like the bills of a duck.

Expectation is a very important element in directing our interpretation. For example: Try to pronunce *folk* in various ways. Repeat aloud the various pronunciations. Now try *polk* the same way. Now pronounce *yoke*. Note carefully the difference in the pronunciation of *polk* and *yoke*. After you have repeated these over so that you have discerned the difference pronounce the word for the white of an egg. You may say *yolk*. But of course the white of an egg is not the yolk. If you slipped and said *yolk*, it was because the material prepared you so that you made a mistake which on the face of it appears ridiculous. If the text did not trip you, try it on some friend.

Secure a lump of lead and a piece of light wood or cork. With the help of scales make sure that they weigh exactly the same. Paint or cover them so that they appear the same. Then ask your friends to lift them and tell you which one is heavier. They will probably without exception state that the lump of lead is much heavier. The reason for the error is this. They see the two and expect the larger one to be heavier. When they lift it with this expectation they find the cork is lighter than they expected and so judge it lighter than the lead.

If you have ever been sitting in a railway coach expecting the train to start, you may have experienced the following error of perception. Should the train next to yours begin to go in the direction opposite to the direction in which you expect your train to move, you will feel that your train is actually moving and can not be convinced of your error until you see the train shed is not passing

by the window or get some other evidence of your error. The expectation makes you interpret the relative motion between the two trains as a movement of your car rather than the other. In this case the illusion is strengthened by other perceptual factors. Past experience has taught you that transportation through space is accompanied by a moving field of vision. When, in this case, you perceive the moving train, you accept it as a cue that you are moving.

Hallucination. — This same factor can account for a perception when there is apparently no stimulus to explain it. Such an experience is called an *hallucination.* They are commonly known as "visions" if they are seen, or "voices" if they are heard.

As an example of a simple type of hallucination, take the case of a boy, expecting to hear his mother call him. He actually answers a call he thinks he hears. He may find that his mother is nowhere around and so could not have called him. In such a case it is likely that another sound stimulated his ear and that he misinterpreted it. This accounts for a number of the so-called messages from the dead. The person has been bereaved and thinks so much of the departed one that he gets to the point where an unrelated sound is heard as the voice of the departed or a queer pattern on the wall is seen as the return of the spirit.

Fear is a strong factor in the production of hallucinations. We are all familiar with the stories of the boy going through the woods seeing every tree as a burglar or a hobgoblin of some sort. If one is afraid of burglars, he interprets every creak of the house as footsteps. The perceptions that he has are merely projections of his own fears.

Here again one needs to check up on his perceptions by tests from other senses and by experiment. Suppose one wakens in the middle of the night feeling sure that he has seen the flash of a burglar's lamp and has heard footsteps in the hall. These may be real or projections of his fears. If he lies in bed listening, he will continue to perceive everything in terms of the fear situation. To check up he gets up and explores and when he finds that the wind is blowing the blinds and making the noise he thought was produced by footsteps, his perception is corrected.

If one who is molested with hallucinations followed the same procedure, he could in many cases rid himself of the visions or voices. He, however, is probably filled with a desire to prolong the unreal situation; and this desire makes it continue to appear real. He does not want to find evidence to disprove it. Very recently a woman produced a vast amount of material that she said was messages from her son who was killed in France. A year later the boy appeared sound and healthy. The messages certainly came from nowhere except her own nervous system. She wanted to hear from her dead son and she did get messages from within herself. Had she been anxious to learn the truth, she never would have been deceived.

Perception of Visual Space

One dimensional space. — The question often arises, "Where is a perception?" When our finger is injured, where is the pain? If we sever the nerve between the finger and the brain, we do not feel the pain. Is the pain then in our head? If we could stimulate the nerve some-

where on its pathway from the finger to the brain, we might produce a pain sensation; but in such a case the individual would feel as though the pain were in his finger. It has been reported that a man with his leg amputated has been able to feel the ache in his corn. How could this be when the entire leg is gone? It is quite likely that the nerve end at the amputated stump was irritated and the pain projected so that the man felt it in his corn which he no longer possessed. "How is it that we feel the pain in the end organ, the finger or the foot, when it actually is in our head?" we ask. The answer is that the perception is not localized at any one spot. The perception is the whole thing — both the stimulus carried to the central organ and the reaction to that stimulus. Let us try to get rid of the idea that our nervous system functions in sections. It has to function as a whole and when it does not, we have a peculiar and abnormal condition resulting.

What is the value in this unifying process of projecting perceptions so that we feel pain in our finger, that we see the table outside our bodies, that we hear the voice coming to us from the outside? It is only as we have been enabled to project these perceptions accurately that we can react to the situations of life successfully. Suppose we did not project the pain from touching a hot stove to our finger — that we felt it only in our heads — the finger would burn up before we could draw it away. Suppose the perception of the table existed solely in our heads. We could never place papers on it to advantage or eat our food from it. Projection of perceptions is a most valuable aid to us. But let us remember that the *perception is neither outside us nor exclusively in our brains, it is the complete process.*

Our problem is to study how this is brought about. It comes about through learning. It is now our task to see how this learning takes place.

Two dimensional space. — We learn that things are spread out in two dimensions, as objects appear in a picture, by a combination of movements with successive sensations. If we touch a book on the table and then move our hand to the right and feel a pencil, we know that these two are spaced even though our eyes may be closed. If we look from one object to another, we get two visual sensations separated by a movement of the eyes and the same sort of learning results. On the other hand if we feel two successive impressions on our hand, for example, when the hand does not move, such impressions are usually accompanied by changing visual sensations or by some other check which indicates to us that the relative positions of objects have changed and these changes are related to our sensations of touch.

In such experiences there is more involved than mere succession. The different experiences have to be related or associated with each other. The feeling of an object moved across the hand is associated with seeing it move, or seeing it change its relation to other things. So, in building up our notion of things as spread out, we again use the coördinating process which we have already found is the basis for all mental life. Let us remind ourselves again that this coördinating activity is really the procedure outlined as scientific procedure. We get a mass of data, we relate it, and then react to it. This coördinating is the formulation of a hypothesis as to the meaning of the mass of experiences and the reaction is a sort of experiment. If we have made a wrong guess, our

reaction does not turn out so well and we must try again. It is perception that keeps our activity from being sheer guesswork.

As we come into more complex and intricate situations the number of factors that must be related become more numerous and our task is harder. This can be seen from the way in which we build up our notion of distance or depth; that is, our perception of three dimensional space.

Perception of distance involves any and all impressions from different senses that can give us any information about the relative distance or nearness of objects. The visual factors play the most important part. These can be divided into factors that come from vision from one eye and those that come from the use of the two eyes together. A person using only one eye can get a notion of distance but he has a harder task than a person using two eyes.

Perception of Distance

Monocular factors. — 1. *Clearness of outline.* — If objects are sharply outlined, it usually means that there is little atmosphere between us and the object, so we learn to interpret clearness as meaning closeness. Other factors than distance can affect clearness, however, and we are likely to make mistakes if we depend on this factor alone. Anyone who has traveled on a foggy night will know how he is deceived as to the distance of oncoming objects. The fog makes them look distant and he is surprised at the quickness with which they come on him. One can not safely take a chance as to the distance of an oncoming car on a foggy night.

2. *Superposition.* — The distant object is partially covered by the one which happens to be nearer. When we see the outline of an object broken by the interference of another we assume that the former is farther away.

3. *Shadows and shading.* — There is only one possible situation in which objects would show no shadows and that would be if the only source of light was located exactly where our eye is. This would illuminate every particle that we could see equally. No such situation is ever possible, so that some parts of our environment are bright and others shaded. These shadows we soon learn to interpret as indicating distance or depth. It is one of the most important monocular factors that we have. So effective is it that we can take a picture on a plane surface and if it is shaded correctly we actually see the objects as at different distances. For example, in Figure 59 we can make the plane square look solid by merely adding a little shading at the proper places.

FIG. 59. — SHADING AS AN INDICATOR OF DEPTH

The shading makes the square on the right stand out from the page as though it were solid.

4. *The size of familiar objects.* — Anyone who has used a camera knows that in order to get a larger picture we move the camera closer to the object, while to get a smaller one, we move the camera farther away. The same thing is true with the eyes. The nearer we are to the object, the larger the image that is projected on the retina. Consequently we soon learn to consider an object, with which we have become familiar enough to know its approximate size, nearer when it is large and farther

away when it looks small. Thus, if we have images on our retina of two men, one small and the other very large, we judge the smaller one to be farther away.

Figure 60 gives an example of where this factor is misleading. The pineapple is much larger than the cow and

FIG. 60. — RELATIVE SIZE AND DISTANCE

The above picture was drawn from an actual photograph. The man was standing on the top of a house. The house is only faintly discernible in the background. Since we have not enough factors given to know the relative distance of the man, the cow, and the pineapple, we can not from this illustration form any accurate judgment as to the size of the pineapple. It looks absurdly large.

also the coconut palm in the background. The pineapple looks immense even though we know something about its real size. The man standing above makes the

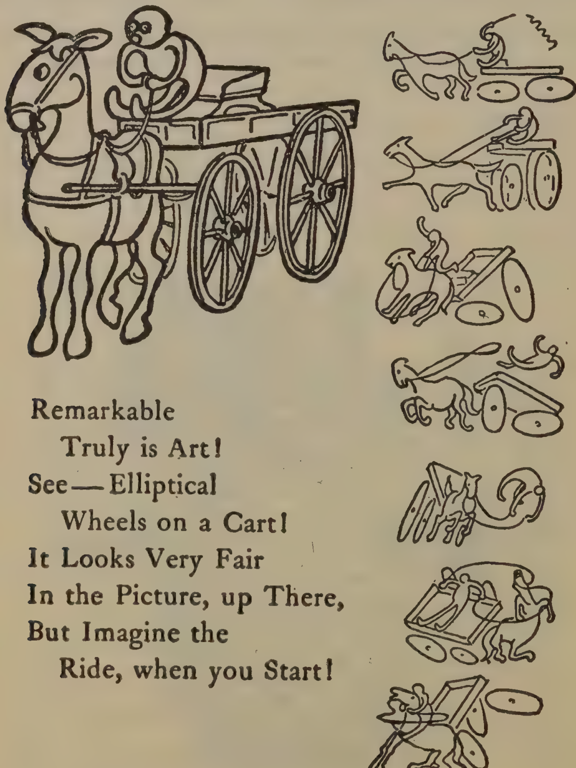

Fig. 61. — A Study in Perspective

(Reprinted by permission of Frederick A. Stokes Company from *The Burgess Nonsense Book* by Gelett Burgess. Copyright, 1901, by Gelett Burgess.)

illusion most grotesque. It looks as though he were standing on two of the pineapple spines, hence, we can not imagine him as far in the rear as would be necessary to

account for the disparity in size. This illustration shows that we need more factors than mere relative size to make an accurate judgment of distance.

5. *The shape of familiar objects.* — We know that a wheel is round. If we see it as round, we know that we are facing it squarely. If it is turned at an angle, one side of the wheel is nearer to us than the other. In such a case the visual image that we get of the wheel is not round but an ellipse. Consequently, when we see a wheel as an ellipse we know that one side is nearer to us than the other. Figure 61 is a humorous illustration of this fact. It again demonstrates that we interpret things in terms of our experience and not as we see them.

6. *Relative motion.* — Whenever we move, things which are near us move past more rapidly than things which are farther away. Hence we can judge relative distance at times by moving our heads. An illustration of this is found in attempting to judge the relative distance of telephone wires. They appear to cross each other and sometimes seem to be in actual contact. If we move our heads we can see that the point of seeming contact shifts. Increase the scope of our movements and alternate these movements and we can decide which is the nearer wire.

An interesting illusion comes from this factor. If you are moving along smoothly, as would happen if you were floating down a stream in a canoe, it sometimes seems as though the canoe and the trees on the bank were stationary and that the trees in the distance were moving at a rapid speed. Or, one may imagine the canoe standing still and the trees on the bank flying by at a rapid rate. The movement of the canoe changes the relative positions of the canoe, the trees on the bank, and the distant

trees. This relative change can be interpreted as a change in the position of the canoe, the trees on the bank, or the distant trees. It takes more observations than the relative positions of the three factors to determine which is really in motion.

Binocular factors. — That perception of depth by the use of one eye is not nearly as accurate as that when both eyes are used can be demonstrated by a simple experiment. First close both your eyes. While they are closed have some one hold a pencil about 18 inches in front of your face. After he has placed the pencil, open one eye, being careful not to permit the second eye to open at all. Then with a sweeping motion of the arm from one side with the index finger pointed in the plane of the motion try to bring the tip of the finger into contact with the pencil. It will be found that you will not, except by chance, be able to make immediate contact accurately. If you try the same thing with both eyes open your accuracy will be greatly increased.

1. *Convergence.* — When we fix our vision on an object, the eye turns so that the object fixated falls on the fovea or point of clearest vision on the retina of the eye. When we use both eyes and fixate on an object at a distance, the eyes turn outward. When we look at a near object, they turn toward the nose. This can easily be observed by watching the eyes of another person. When a person looks at you, you can tell by this factor whether he is looking at you or whether he is looking " through you " and fixating on a distant object. What we ordinarily call a " stony glance " occurs when the person is seemingly looking at us but his eyes are turned as they would be, if he were looking at an object farther away from him than we

are. The way in which this operates may be made clear from the diagram in Figure 62.

This factor of moving the eyes toward the nose when looking at a near object is called *convergence*. As far as has been determined it is present at birth. A newborn

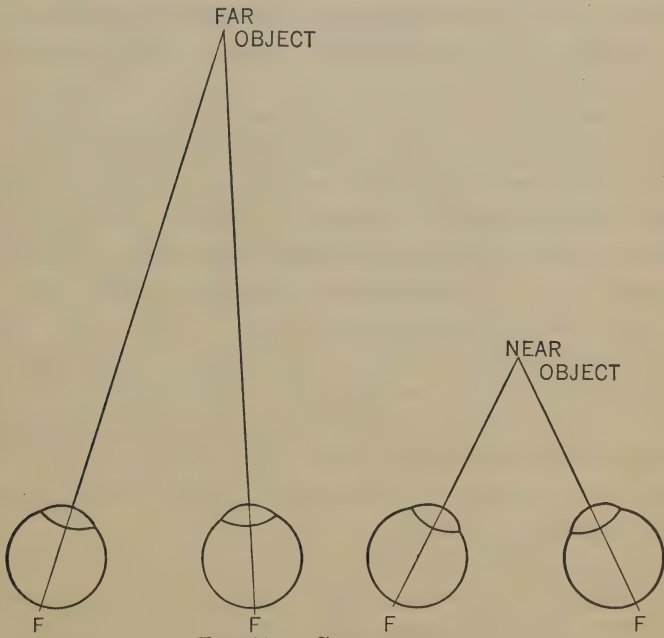

FIG. 62. — CONVERGENCE

When changing the point of fixation from a distant to a near object the eyes rotate so as to bring the object on the fovea of each eye.

child will move his eyes in harmony. However, in a newborn child it is not as well established as in later life. You may observe a child seemingly looking at an object and yet his eyes seem turned in different directions, both not fixated on the object. This may be lack of ability to coördinate the movements of the two eyes or

it may be lack of ability to attend properly to the object because he has not learned its meaning.

Whichever the cause, the child learns in both directions. He makes his eye movements more accurately as he grows older; and he learns to fixate his vision on the significant objects in his surroundings, because he has learned the significance of the different objects — he has learned their meaning.

2. *Disparity of the images of the two eyes.* — When we look out about us, most of us think that we see the same thing with both eyes, but we do not. You can easily demonstrate this to yourself as follows: Hold a book directly in front of you with the bound edge of the book toward you. If you will now close your right eye, you will see the bound edge and part of the back cover. Open the right eye and close the left and you will see the bound edge and part of the front cover. When you look with both eyes you will see the bound edge and a small portion of both the front and back covers. It is the combination of these two dissimilar images that gives you the impression that the book has depth.

If you hold the book very close to your face and repeat this experiment, you will find that the difference between the two images is much greater than it is if you hold it farther away. In fact you can hold it so far away that it takes very close observation to note that there is a difference between the two images. Thus you may see that when we get images that combine into a single impression but in which the two images are greatly different, we interpret the object as being near. When they are very much alike we are likely to interpret them as being far away.

The operation of this factor may be demonstrated by means of the stereoscope. This word is a combination of the Greek word *stereo*, meaning solid, and *scopos*, meaning to see. It is an instrument which enables us to see pictures as solid objects. The principle upon which the stereoscope is built is exactly that of human vision with the two eyes. Photographs are taken at the same time with two cameras separated to the same extent as are the two eyes of a human being. Each of these cameras takes a picture slightly different from the other. These two pictures are then mounted on a card and viewed through the stereoscope. This instrument has prisms and a dividing partition so arranged that each picture is seen separately by but one eye. As we look at the two pictures, one with each eye, they combine and we get a feeling of depth similar to that which we would get, were we actually looking at the scene which the pictures represent. We know that the pictures are not solid, but we can see the solidarity of the objects just as readily as though they were out there in front of us.

Perception of Auditory Space

The ability to determine the source of a sound is very inaccurate. — This can be tested by blindfolding a person and sounding a snapper of some sort at various locations around him. Let him indicate by pointing where he thinks the source of the sound was, and you will find that his guesses are on the whole incorrect.

The greatest inaccuracy comes when the sounder is snapped in what is called the *median plane*. By median plane is meant the surface that would divide the body into two equal right and left halves, passing through the

nose, spinal column, and breast bone. This is evidence in favor of the fact that we judge the source of the sound by a comparison of the sensations from the two ears. If the sound came from the median plane, the sound in each ear, other things being equal, would be identical and no basis would be present to judge location. If the sound came from some source outside the median plane, there would be a difference in the sound that reaches each ear and this would afford a basis for judgment.

Normally we locate a sound by movements and this can only be accomplished when the sound is repeated. If the sound is made but once, we are likely to be at a loss to indicate its source. We turn our heads and listen again, and the successive experience gives us a more accurate means of judgment.

Even at best, however, our localization is very imperfect. Try to locate a squeak in your car and you will discover how inaccurate we all are in this respect. We must hear it over and over again, change our position, crane our necks, and go through all sorts of antics and even then the thing eludes our grasp.

Perception of Time

While vision, as we have seen, is the most important sense involved in the perception of space, hearing and the organic senses give us most of our knowledge about time. This distinction is not clear-cut in that each sense has a particular function, but certainly we get more notion of time relation through audition and the organic senses than we do through vision.

The perception of short intervals, such as two or three seconds, seems to be a process different from that of the

perception of longer intervals. In the perception of short intervals, the feeling of muscle strain, breathing, heart beats, and possibly other bodily rhythms are used as cues.

Longer periods of time are sometimes estimated by reference to these smaller units. Some other factors in the perception of longer periods of time are fatigue, hunger, and similar bodily states. An infant awakes and begins to cry at feeding time. A child is very regular in this respect. Here we seem to have a rather efficient basis for the development of the sense of time. It is likely that adults make considerable use of the amount of fatigue in estimating time. Students sometimes may make use of this method in estimating the length of class periods. Rest, which in this case may be looked upon as the absence of fatigue, has much to do with our ability to tell how long we have been asleep or free from work.

Many secondary cues such as the relative position of the sun or shadows, the amount of work accomplished, or the appearance of some familiar object or event may give us information about time.

Whatever goes on during the interval during which we are estimating affects our estimate. If time is well filled, especially with pleasant stimuli, it seems short. Contrast the apparent shortness of a good show or interesting lecture with a similar length of time spent in waiting for a train. This is true as we look back over a period of time in the immediate past, but just the opposite is true in more delayed memories of time. After a few weeks or months in thinking back over a day spent in pleasant activities the day seems long. On the other hand, our memory of the length of a period of convalescence gives us the impression of its brevity.

Perception in Reading

If you watch the eyes of a person when he is reading, you will notice that they move by jumps. — He looks at one part of the line, jumps to another, then to another until he finishes the line. Then he jumps to the beginning of the next line and repeats the process. This fact indicates that:

1. *We are able to perceive and interpret a series of letters at one glance, or what in psychology we call, a fixation.* — Efficiency in reading depends upon improvement of this factor. If we can only interpret a very small amount of material with one fixation, it means that we must make more stops while reading a line. This will make our reading very tedious. If we can read a line with about four or five fixations, it means that we are more efficient readers than if we have to make ten or fifteen. A study of this factor has shown that for a three and one-half inch line first grade pupils make about eighteen fixations while college graduates make on the average about five. One thing to strive for in developing efficient reading habits is to train the ability to grasp a wide unit of material in a single fixation pause.

2. *It takes some time to grasp and interpret the material that we can take in at one fixation.* — There are wide differences in the time it takes for this. First grade pupils average something over half a second for each fixation while college graduates average about one-quarter of a second. Quickness of perception is then another factor that can be trained and it is evident that its improvement will constitute a big factor in improvement in reading ability.

3. *Learn to make eye movements and stops with regularity.* — One main difference between a good reader and a poor one is that the latter is very irregular in his eye movements. A poor reader will move ahead and then jump back. He will jump too far, pause, jump back too far, and then advance. A mature reader is able to move regularly from one fixation point to another. He has learned not to make too many fixations, not to pause too long on each one, and to interpret each in connection with the next, so that it is not necessary to retrace his vision.

QUESTIONS

1. What is the relation of sensations to perception?
2. What is perception?
3. Show how the unification of experiences is an important factor in perception.
4. What material other than sense material is present in a perception?
5. Could we perceive anything concerning which we have had no previous or present sense experience? Explain.
6. What does "cue" mean in psychology? Have several persons look at the same object and list the cues they get from it. Compare the lists. Explain any differences that are found.
7. What is the significance of Woodworth's statement, "We see things not as they are but as we are"?
8. How do you tell one person from another when each is seen at some distance?
9. Describe the features of some one you have recently seen and then check up on the accuracy of your description. Account for any errors in color of hair, eyes, and complexion.
10. What is an illusion? Describe ~~some~~ common illusions.
11. Why do we perceive the staircase figure (Figure 56) from above more often than from below? Why might this not be the case with a person who has lived in a basement?

12. Why does a person who is inferior hate to mingle with those greatly his superiors?

13. Why is it that ghosts are always reported to have been seen in dark, creepy places?

14. Criticize the adage, "Seeing is believing."

15. What is the difference between an illusion and an hallucination?

16. Give evidence to support the statement that hallucinations are projected perceptions.

17. Experiment with your ability to estimate distance with one eye and with both eyes. Perform a number of such experiments and in each case measure the actual distance. Explain the results that you obtain from these experiments.

18. Why do we generally misjudge distance in a fog?

19. What are the monocular factors that enter into the perception of depth? What are the binocular factors?

20. What is meant by convergence?

21. What do we mean by disparate images? What part do they play in the perception of distance?

22. Explain the operation of the stereoscope.

23. From your own experience get some illustrations of the inaccuracy of sound localization.

24. Check your ability to estimate the time under different circumstances such as when reading an interesting book, when doing hard physical work, when waiting for twelve o'clock to arrive, when waiting for a friend to keep an appointment, and when reciting. Explain the differences you find.

25. Describe the movements of the eyes during reading.

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CHAPTER IX

LEARNING

Methods of Learning

In the chapter on perception we have seen how complex mental states called perceptions have grown from simple mental states called sensations. We may say that much of this growth of sensations into perceptions is natural, unintentional learning. The child may develop his ideas of an orange and other objects about him in an undirected way. But all learning is not undirected. The wise parent, the kindergarten teacher, the grade and high school teacher are all deliberately trying to help the child or pupil in the acquiring and growth of percepts. The child that has had the widest experiences and has been the most wisely directed, other things being equal, will have the broadest and best fund of percepts. Of course the child has to have something to do with the process. This work can not be done for him. He must have the capacity to learn and he must participate actively in the process. The parent and teacher can only help in the process by providing him the opportunity to experience the object or event and direct him how to get the most out of it.

The child as well as the adult is not only developing percepts. He is also learning ways of doing things. He is acquiring methods and skills in hundreds of ways. The general methods in the acquiring of percepts and skills are practically the same. In this chapter we will be concerned with how this learning takes place.

In earlier chapters it has been pointed out that the child has certain predispositions to act in certain ways. He has certain reflexes, instincts, and emotions. Whenever the right stimulus comes along, he behaves in a certain way without previous training. These are the innate tendencies, the basis upon which all learning is founded. In the lower animals this original outfit is rather rigidly fixed and constitutes the animal's whole behavior. In the higher animals, and especially in man, these original tendencies are not so definite in form. Instead of there being only one reaction possible, there are many. The ant will try one way of getting out of a pen, and, if it does not succeed, will try it over and over until it becomes tired out. A child will try one way and, if that does not succeed, he will try another and another until he finds a way to get out. The use of different methods is the basis of learning.

In terms of the nervous responses there are five different methods of learning. — 1. *Strengthening of already established pathways.* — In this learning there is a native pathway all ready to function. Any adequate stimulus brings on the response. But practice makes the response quicker, more exact, and easier. There are no new paths in this learning. It is merely a strengthening of native nervous pathways as a result of use. A child instinctively cries. The more he cries, the easier it is to cry and the

more he will cry, unless some opposite condition is set up. Some adults have grown up without having learned any better way to get what they want than by crying.

Chicks learn to pick up food by this method of learning. It was found that the first time chicks tried to pick up a particle of grain, they were about 11% successful; that is, they were able to pick up and swallow a piece of grain successfully in 11% of the trials. On the second day these same chicks were able to pick up and swallow the grain successfully about 55% of the time. On the third day about 60%. There was steady progress and by the seventh day they had reached about their limit of improvement at 80% correct. Children learn to walk by the same method. They begin and keep on trying until the act becomes perfected.

2. *The second method of learning is called the method of substitute stimulus.* — The mechanism for this method of learning has already been explained on Page 41. It is illustrated in Figure 17. A certain stimulus gives a native response. When another stimulus acts at the same time as, or immediately following, the original stimulus, the new stimulus after being repeated a number of times may come to produce the same response as was brought about by the original stimulus. The case of the dog that heard a bell ring every time he was shown a piece of meat, until finally the saliva began to flow whenever the bell was rung, even if the meat was not shown, is a good example of substitute stimulus. (See Figure 15.) Language is a form of substitute stimulus. If a fire were discovered in the school building the instinctive response would be to run. If someone suddenly should yell "Fire," the same response would occur. The word in

this case is a substitute stimulus and would have the same effect as the fire itself.

The possibilities for substitute stimuli are almost unlimited. Learning a foreign language is only learning to substitute some other word for our English word. Football signals are substitute stimuli which the opposing team can not interpret.

3. *Substitute response.* — This is the modification of the motor side of the reflex arc. The beginning of this method results from the fact that for some reason or other the original native response has not been successful. Other methods of reacting have been tried, until the successful one has been found. It then becomes fixed through practice.

A hungry cat is placed in a cage. The cat tries to crawl between the bars. That is the natural thing for the cat to do. But it finds it can not get out that way. It tries other ways and accidentally turns a button that is attached to the door of the cage. This lets the cat out. If it is again placed in the cage, it may try again to crawl out between the bars but is very soon more disposed to try other things. Again it may hit upon the button and get out. After a few trials the cat may learn the trick and when placed in the cage it will immediately turn the button. This response has been substituted for the more natural response of trying to crawl between the bars.

But substitute responses are not limited to tricks. In boxing, for example, the natural thing to do when a glove or a fist is on the way toward the face is to close the eyes and dodge. This action seldom avails anything, for you generally get not only the blow that is coming

your way, but also a follow-up blow before you get your eyes open. Training and experience in boxing show that it is better to keep your eyes on the opponent and protect yourself, not by dodging as much as by getting the hands up for a defense. These are substitute responses. The reader can think of many other examples of this method of acquiring skill in many fields of life.

4. *The fourth method of learning is combination.* — In this method of learning, the different relatively simpler parts of the process are combined into a more complex act. The parts of the complex acts may be native or they in turn may be the result of learning through substitute stimulus or substitute response. Even as simple a process as walking or running is made of simpler parts. The completed process consists in connecting these simpler parts in more complex combinations.

Playing a piano or pipe organ is an excellent example of learning by combination. The meaning of the notes and their positions on the staff together with a knowledge of the positions on the keyboard must be learned by substitute stimulus or substitute response. The connecting of the note and the striking of the appropriate key comes through intricate combinations. One marvels at the playing of a three-manual pipe organ. It is quite beyond the comprehension of the novice how the organist can play one bank of keys with one hand, another bank with the other hand, strike the bass notes with one foot, kick the stops open or shut with the other foot, and keep these processes going regularly in time and tune according to the directions on the printed score.

5. *The fifth method of learning is that of random responses.* — It may in some instances be only a mixture of the other

forms of learning. There seem to be cases in which there are stimuli, either one or more, that have no native connection with any response. But a nervous current that goes into the cord or brain center does not remain there but must go out to the muscles of the body. There is no specific pathway for its release, but many pathways of about the same resistance. The nervous current may pass over any one of a large number with equal ease. The result of such a situation is what has been called *random movements*. Of these movements some are found useful and so are repeated on similar occasions. This repetition fixes them so that they come as an immediate response to the stimulus which at first caused only random activity. Much of the infant's learning is of this type. His time is taken up with sheer activity — kicking and waving his arms. He finds some of these movements to be valuable and so learns to select the useful from the useless.

The five different methods of learning overlap each other. They are not clear-cut and distinct but tend to merge into one another. Whether an example illustrates one method or another often depends upon the point of view. Yet each method has its own characteristics, and all five methods seem necessary to account completely for the learning process.

The Laws of Learning

The three laws of learning. — Thus far in this chapter we have been dealing with the methods of acquiring new ways of reacting. In this part of the chapter we shall be interested in how these acts become fixed. The ways by which reactions become fixed are called the *laws of*

learning. Although the process of learning is very complex, the laws that govern the process are relatively simple.

1. *The law of use.* — The first is the law of use. This law states that, other things being equal, *the strength of any learned act depends upon the number of times the act has been performed.* This law applies to any of the methods of learning previously described. Some of the native pathways have a low resistance to begin with. Even so, practice or use further reduces the resistance in the pathway. In the acquired pathways, practice lowers the resistance. The pupil who repeats a poem or a theorem in geometry the largest number of times, other things being equal, will have it learned better and can retain it longer than the pupil who has not repeated it so often.

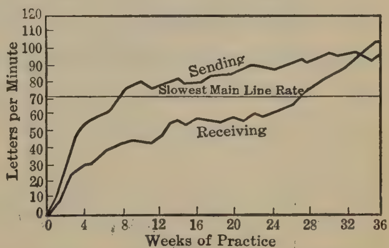

Fig. 63. — How One Improves When Practicing Telegraphy

The most rapid improvement comes in the first weeks of practice.

While use strengthens a learning process, the same amount of practice may have different effects depending upon whether it comes early or late in the process. Ordinarily the first practices are more significant than later practices. This is only another way of saying that learning takes place more rapidly in the beginning of the process than later.

Several important studies have been made of learning which indicate this fact very clearly. Many years ago Bryan and Harter studied how students learn telegraphy. The curves in Figure 63 illustrate the progress made in

telegraphy as practice is continued. There is a curve for sending and one for receiving. The height of the curves indicates the letters received or sent per minute. The distance along the base line represents weeks of practice. The curves are read in this way: Select any period of practice on the base line. The place where the curve crosses the perpendicular erected from this point will be opposite the number of letters the person can receive or send at this stage of learning. For example, the curves tell you that after four weeks of practice the learner can receive

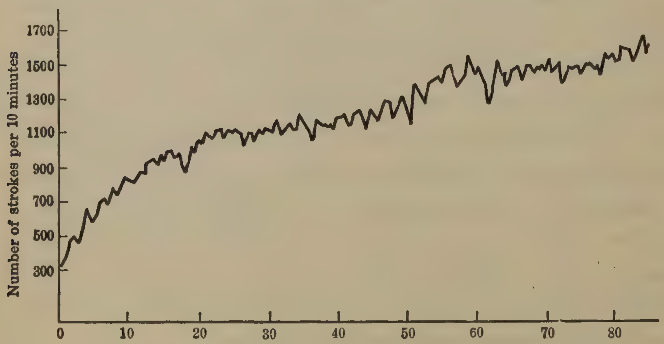

FIG. 64. — LEARNING CURVE OF TYPEWRITING

This curve shows improvement in typewriting by the touch method. Here also the most rapid improvement comes in the first stages of practice.

30 letters per minute and send about 52 letters a minute; after 28 weeks of practice the learner can receive about 75 letters a minute and can send about 95 letters a minute. It can be seen from these curves that the most rapid progress comes in the first weeks of learning.

W. F. Book in like manner studied progress in learning to typewrite. He found the same general facts that were found in studying telegraphy. (See Figure 64.)

A study of the curves in Figures 63 and 64 will show that there are certain points in the learning process where there is no apparent progress. These places, where there is no apparent progress, are called *plateaus*. They are so called because they form a level spot in the learning curve. The number and length of these plateaus differ with the material being learned and with the people who do the learning. Sometimes these plateaus extend over short periods of only a few days and sometimes they may last even for weeks. In athletics we say that the man has "gone stale." The problem arises as to the causes of the plateaus and whether it is possible to eliminate them.

It seems likely that some plateaus are inevitable. One explanation has been that they are due to periods where one type of habit is being fixed before a habit of a higher order can be started. For example, in learning telegraphy there is a period during which the learner must practice the sending of single letters. After this becomes fairly well fixed, he gets to the point where he can not increase his speed in sending single letters. He can now change his method and begin the problem of sending words as units instead of letters. This is really a new habit he is beginning to practice and as he learns this new complex procedure his curve shoots upward again. After he has practiced sending word units he gets to the limit of speed again and there is another level place on the curve. He may then start sending with phrase units and again his curve will go upward until the limit of improvement is reached with this method.

This same factor operates in learning to typewrite, in playing the piano or other musical instrument, and in

acquiring many acts of skill. A plateau may not be a sign that the person has gone stale. It may mean that he is fixing some simple process and getting ready thereby for the next jump ahead when he begins the more complex type of performance. *This type of plateau probably can not be eliminated.*

Other experimenters have found plateaus closely related to a loss of interest. After the initial start interest in a subject or project is likely to wane. At this point a plateau will appear. With the return of interest the plateau will disappear. *Plateaus due to a loss of interest can be eliminated.* It is a problem for the pupil and teacher to see that such plateaus do not appear. They are wasteful and unnecessary.

There is a certain and obvious limitation to the law of use that should be stated here. It has been mentioned that the rate of learning is more rapid in the early stages of learning than in the later. In most if not all learning there is a point that may be reached beyond which little learning can take place. This point is called the *physiological limit* or it may be looked upon as the final plateau. Practice and training will improve an athlete's running time, but relatively few can run the hundred yards in less than ten seconds with any amount of practice. Practically any person can improve his rate of typing, but few of us could ever learn to write more than sixty words per minute. It is true that many of us have assumed that we have reached our limits when we have not. Expert accountants and telegraphers who have seemingly reached the limits of their learning, when given a more responsible position, have almost invariably excelled any previous record. Just now pole vault records

are being broken regularly with Charley Hoff, the Swedish vaulter, leading the race with nearly 14 feet. Incentive is the great factor in surmounting supposed physiological limits.

2. *The law of disuse or forgetting.* — The complement of the law of use is the law of disuse. Any learning process that is not practiced, gradually decays. If you have not studied Latin or algebra for a year or two, you have forgotten much that you once knew in these subjects. But it is not necessary to wait a year or two for the law of disuse or forgetting to take effect. It starts during or at least immediately following the practice period. Ebbinghaus, a well-known German psychologist, found that with material without meaning, like numbers of nonsense syllables (such as *bap*, *mung*, etc.), more than half the material had been forgotten at the end of one hour. At the end of the first day 65 per cent had been forgotten. Others have repeated these experiments and have found almost as rapid forgetting.

If the material that has been learned has sense or meaning, like poetry, the rate of forgetting is not so rapid. In learning poetry it has been found that the rate of forgetting is very rapid at first but less rapid after the first few days.

With motor acts like skating or typing the rate of forgetting is still much slower. The writer remembers getting on a bicycle for the first time in five years. After a few peculiar sensations at first he seemed quite at home and there had been apparently little loss in efficiency during this time. A person who has learned to swim probably never forgets how to swim. Swift found that after a year and a half without practice in ball tossing, his

subjects were able to average their last best record in the first day of practice. After over four years without practice, they had almost lost their skill, but in ten days' practice they were one-third above their best accomplishment of forty-eight previous practices. Swift also found that after two years and thirty-five days without practice in typewriting, it took his subjects only seven days to reach the standard they had obtained in forty-five days' practice when they were first learning to typewrite.

Thus we see that the rate of forgetting differs with the type of material. It is most rapid with material that has no meaning, less rapid the more sense there is to the material, and least rapid with acts of motor skill.

The rate of forgetting also seems to differ with the age of the learner. In two or three studies the rate of forgetting for children was much less rapid with sense material than for adults. After a week, little of the partially memorized material seemed to be lost.

3. *The law of effect.* — Some psychologists have claimed that the laws of use and disuse fully explain the learning process, but common sense and experiment prove that they do not explain all learning. Any parent, teacher, or child knows there is little skill acquired in the half hour spent by the pupil in practicing the piano when his interests are in the ball game going on outside. The practice may be justified on the grounds of discipline but not upon the basis of the gain in piano playing. Most gain comes in those things in which there is a real interest. Many experiments have been performed with animals in running a maze with two runways. If such an experiment is so arranged that in one runway the animal gets an electric shock and in the other he gets food, the animal

will soon learn to go to the runway that leads to the food. Pains and pleasures, rewards and punishments, are the usual means of control in the training of both animals and children.

The law of effect states that, independent of the number of trials, *those acts which give us satisfaction tend to become fixed and those acts whose results give us annoyance are not so easily fixed.* Given an equal number of trials in each of two ways of trying to do the same act, and the way that brings success is learned while the way that brings failure is not learned.

Many other laws of learning have been listed by different writers but the laws of use, disuse, and effect, with their corollaries, seem fully to account for any process of learning. In the interest of simplicity as well as truth the list is closed with these three.

Efficiency in learning. — It has been said that one of the purposes of psychology is to give us more leisure time. If this is correctly understood it is a legitimate aim of psychology. It should teach us how to study more efficiently so that we can learn our lesson in a shorter time or learn more or better lessons in a given time. The three laws of learning that have just been mentioned may fully account for all learning but there are certain ways or techniques by which learning may be accomplished more efficiently than by other methods. Every student should be interested not only in learning but in learning how to learn most efficiently.

1. *One important factor in learning is the intention to learn.* — Too many pupils have this attitude in study and in the classroom: "Well, here I am, teach me if you can." It has been found by experiment that with the

same amount of practice on two equally difficult problems, the material of the one that is studied with the definite intention of making the learning permanent is actually retained longer than the material studied without such intention.

The story is told of a student who was given the task of learning a list of nonsense syllables. He was expected to learn the series so that he could repeat it by heart. The

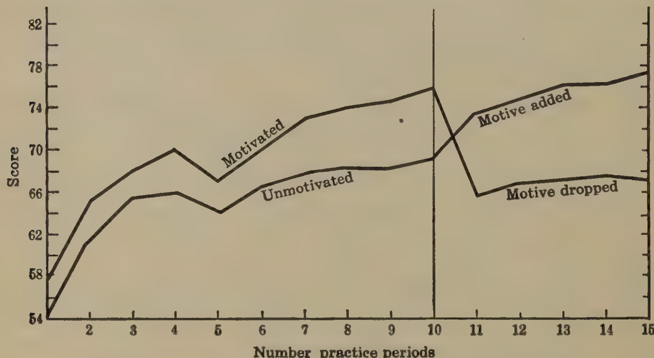

FIG. 65. — EFFECT OF MOTIVATION ON LEARNING

The task was the writing of as many legible "a's" as possible during a 30 second period. During the first ten practice periods, the group motivated by being shown their scores made greater improvement than the group which did not learn the results of its work — the unmotivated group. From the tenth day the motivation was reversed. The first group, now not permitted to see their progress, began to lose at once, whereas the other group, on studying their scores, progressed rapidly. From Gates, *Elementary Psychology*.

student misunderstood the directions and had been studying the syllables carefully but had not been trying to learn them as a series. A test showed that he had learned only a very few of the series.

Figure 65 shows the effectiveness of incentives on a learning curve. Up to the tenth practice period one group of students was given incentives to learn while the

other was not. After the tenth period the situation was reversed and the group that had the incentives was no longer given them. The group that had not been given these incentives was given them. The curves speak for themselves.

In another experiment students were asked to name one hundred colors from a card as rapidly as possible. These hundred colors consisted of only five different colors arranged twenty times in irregular order. After the students had named this list of colors over two hundred times they had very little memory of the order of the bits of color. They had not been trying to learn the order of the colors.

In another investigation the teacher told his class he wanted to test their ability to spell a list of words. When six words had been written by the students the papers were collected. The students were then told to write from memory, in order, the six words that had just been spelled. Of 236 students only 12, or 5 per cent, recalled all the words in their proper order, twenty-five per cent could recall the words but not in their correct order.

2. *We learn best by doing.* — Should the teacher help the pupil? Teachers and parents differ greatly on this problem. In some schools pupils are given to understand that they must work out their own salvation. Little help is given. The teacher's main function in such a school is to see that the pupil learns his work. In other schools the teachers give a great deal of help to the pupils. Some pupils have their parents, older brother, sister, or friend solve their school problems, especially problems in mathematics. Such students may copy the problem to hand in to the teacher but that is all they learn. We

learn by doing and about all the pupil who copies problems learns is how to copy.

But there is help that the teacher can render. He can explain the nature of the problem to the pupil and help him on a problem that he could not otherwise solve, and then give him a similar one to see that the principle has been mastered. The teacher also has another very definite function of helping the pupil develop efficient methods of study. The teacher has a very definite function in the school room beyond the problem of keeping order and keeping pupils at work and it does not consist in doing the work for the pupils either.

Many teaching devices have been invented which are supposed to shorten the learning time. Children have been taught to write by following the letters made in the form of grooves in wooden blocks. Many children have spent hours drawing maps on waxed paper held over geography texts. In reading, children have been taught beginning reading by the use of diacritical marks. The significance of these marks is learned only to be discarded later. Such practices have a doubtful value. It would be better to spend the time in active study or work by the pupil; the more active and well directed the work is, the better.

3. *A further factor in efficient work is good working conditions.* — This does not mean that every pupil should have a private study or that a study hall should be perfectly quiet. But too often the opposite is true. The pupil who must study with some interesting conversation or game going on in the same room is working under a serious handicap. It is true that some studies have shown that a certain amount of distraction really is an

aid to good work. It has been claimed that the average newspaper editor could not do his best work without the noise of the typewriter, the linotypes, and the presses. Yet as a rule distractions should be avoided. It is difficult enough to do one's best work under the best conditions.

4. *It pays to work vigorously.* — Most of us are plodders. It has been shown that most of us could read from one half to twice as fast as we ordinarily read and get just as high a percentage of what is read. Groups of elementary, high school, and college students were asked to read a series of three short paragraphs. One series they were instructed to read at their normal rate. Another they read as rapidly as they could read and the other series they read slower than their normal rate. The pupils wrote down everything they could remember after each reading. The paragraphs were rotated so that each paragraph was read normally, rapidly, and slowly the same number of times. The results show that rapid reading is much the most efficient.

NUMBER OF IDEAS GAINED PER SECOND IN READING PARAGRAPHS AT DIFFERENT RATES

	4TH GRADE PUPILS	7TH GRADE PUPILS	HIGH SCHOOL PUPILS	COLLEGE PUPILS
Slow reading . .	.134	.234	.195*	.242
Normal reading .	.183	.266	.251	.416
Rapid reading . .	.256	.293	.329	.566

* The same paragraphs were not used with the different grades. This accounts for the variations in the number of ideas for the different groups.

5. *The length of work periods is important.* — How long should we study at one time? If we have an hour to

spend in preparing a lesson, is it better to spend it all at one sitting or break the time up into two or more study periods? Many studies of these problems have been made but the answers are not conclusive. The best length of practice periods depends upon the kind of material to be studied and the age and ability of the pupil. This problem will be taken up again under memory. It is quite likely that work periods should be shorter for memorizing than for the learning of motor acts.

Transfer of training. — Another important question in learning is: What should we study? Does it make any difference? Many of us have been told by teachers: "Get busy, it does not make as much difference what you study as that you study something." The theory back of such statements is that if you study anything, the influence of this study will spread to other phases of your life and you will experience a sort of general improvement. There may be some truth in this statement but that it is limited in its scope is unquestionable. The teacher would probably have objected if you had begun diligently to read some cheap novel or to play checkers.

Although it does make a difference what you study, no definite rules can be set forth. In general we should study the thing that we will need most in later life. This should not be interpreted as a plea for manual training and commercial courses even though they have their place in the high school. Life is, or at least should be, more than some occupation. There are other values to be considered; cultural, social, and personal qualities that have only a vague relationship to life's occupation. In general, however, direct training is best. If you wish training in medicine, study medicine and the things di-

rectly related to it. To study Latin in order to make it easier to learn medical terms is a wasteful way to learn medical terms. Study Latin for the value that it has for you and study medicine for the value it has.

It has been found that such an unrelated thing as card sorting may aid in typing, but the amount of help is so small that if one wishes to learn typing, one had better practice it and not the card sorting. There have been many experiments on the effects of practicing one thing on success in another, or transfer of training, as it is technically called. A careful interpretation of the results indicates that there is a transfer or improvement wherever there is a relationship between the practice material and the thing to which it is transferred, and that the amount of transfer is proportional to the relation between the two traits. Study in one field will not help in acquiring skill in an unrelated field.

Does it pay to study? — The question may legitimately be raised at this point as to whether study is worth while. Many pupils seriously question whether study will profit them in proportion to the amount of effort required. There are some definite answers to this question. All studies of high school and college grades have shown that those who make good in high school are more likely to make good in college. Dean Kent presents the following evidence on the subject:

For some years the College of Liberal Arts of Northwestern University has kept track of Freshmen admitted from the fourth or lowest scholastic quarter of the classes in which they graduated from high school.

There were 72 such students who entered in the fall of 1919. A study of these through the four years following yields this interesting information:

Four, averaging slightly better than a C grade (75–80), were graduated from Northwestern University, College of Liberal Arts.

One, with slightly less than a C average grade, was graduated from Northwestern University, College of Liberal Arts.

Seven, with less than a C average grade, transferred to other Northwestern departments than Liberal Arts.

Four, with an average of C grade or above, transferred to other institutions.

Eighteen, with less than C average grade, transferred to other institutions.

Two, with better than C average grade, dropped college work entirely.

Thirty-six, with less than a C average grade, dropped college work entirely.

In this connection the reader should know that to graduate from this College a student must have an average of not less than C in the work of his four years.

Quarters According to College Grades	High School Quarters				
	1	2	3	4	Unclassified
1st (1.60) and up)	181	31	7	1	45
2nd (1.00 to 1.50)	105	66	38	6	79
3rd (.30 to .99)	48	73	61	36	102
4th (.29 and below)	32	40	43	40	129
Totals	366	210	149	83	355
1st	49%	15.1%	4.7%	1%	13%
2nd	29%	31.4%	25.5%	7%	22%
3rd	13%	34.5%	40.9%	44%	29%
4th	9%	19%	28.8%	48%	36%
Totals	100%	100%	100%	100%	100%

The above table shows that among the total 1,163, only one who is ranked in the fourth quarter of his high school class reached the first quarter in college, six reached the second quarter, and seventy-six remained in the lower half. On the other hand, out of 366 who came from the first quarter of their high school class 78 per cent remained in the upper half of their class in college while only 22 per cent dropped to the lower half.

In short the table shows very clearly that there is a marked tendency for students to do about the same type of scholastic work in college as they did previously in their preparatory school.

But let us look at the entire entering group instead of merely a part of it. The number of students included in this study was 1,163. The table opposite shows the quarterly standing in both high school and college work of the 1,163 students in the Liberal Arts classes of 1925–26 who stayed in school long enough to receive grades. The college standing is based on three semesters' work or less (less for those who did not stay three semesters). The perpendicular columns show the high school standing. The horizontal columns show the college standing. The 92 college students not receiving any grades are not included in this chart.

W. V. Dearborn in the report of a similar study made several years earlier at the University of Wisconsin states that "three-fourths of the students who enter the university . . . will maintain throughout the university approximately the same rank which they held in high school." Many other studies have shown that those graduated from college with honors are from two to five times as likely to make good in later life as those graduated without honors. It is true that part of this success is due to the fact that these are superior individuals. They make good in high school and college as well as in later life because they have superior minds. But intelligence is not the sole factor in their success. Habits of work and study are just as great if not a greater factor in their success. Through indolence many brilliant men never do anything of worth and through industry many average men make good in life.

QUESTIONS

1. Upon what factors in the individual does learning depend?
2. Does the capacity to learn develop with age? If so, when does it cease developing?
3. Give an illustration of each of the five methods of learning.
4. What is the difference between a condition of learning and a law of learning?

5. What is the most important law of learning?

6. At what stage in the learning process is learning most rapid? Can you give some reasons for this?

7. What is a plateau in learning? Give some causes of plateaus. How may they be eliminated or reduced in number or length?

8. Give some limitations of the law of use.

9. What kind of material do we forget most rapidly?

10. Repeat the following series of numbers to yourself or to the class once in order, at the rate of one number per second. 8496, 4732, 1492, 3724, 1234, 2235, 1776, 2222, 1685. Then immediately try, or have the class try, to recall all the series they can remember. Explain why certain parts of these series were retained and the others forgotten.

11. How much did Ebbinghaus find was forgotten in twenty-four hours?

12. What kind of material is retained longest? Can you give any examples of your own that illustrate this fact?

13. Would it aid students in learning if they were more interested in learning than they are? Why are students often so uninterested in their studies? Can you suggest methods for improving these conditions?

14. What is the reason for having students do experiments in the laboratory rather than having the instructor perform the experiments before the class?

15. What is a distraction? Why may certain things be a distraction to one person and not to another?

16. Is there any justification in hard work? If so, what?

17. How long should we work at a time?

18. Criticize: "It makes no difference at what we work, as long as we work."

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CHAPTER X

MEMORY

Kinds of Memory.
- What things do we want our memory to do?
- Retentivity

Immediate Memory.
- Interest an important factor in immediate memory
- Grouping the material makes it easier to reproduce

Rote Memory.
- Learning by repetition
- Laws of memorizing

Associative Memory.
- Associative memory stresses numerous relationships
- Avoid artificial schemes

Recall Memory.
- The value of recall
- Causes of forgetting
- Methods of recall

Recognition Memory.

Kinds of Memory

The fact that memory plays such an important part in our everyday lives, together with the fact that people vary greatly in their ability to remember things, makes a good memory a very desirable thing. We are very likely, however, to wish for a good memory without knowing exactly what it is that we want.

For example, people have been heard to wish that they could remember everything. Some persons are foolish enough to start out to achieve such an ambition. The writer once knew a boy who could give the exact population by the 1900 census of every town and city of over

ten thousand in the United States. When last seen he had almost finished committing to memory the 1910 census. This might be interesting but it is very unprofitable. Anyone could easily find such information in the proper source. This same boy had repeatedly taken the examination for an elementary teacher's certificate and had failed each time. It would have been better for him to have spent some of his time studying the things that were called for in such examinations.

If our wish to remember everything we learned were gratified, we should find ourselves in very uncomfortable situations. Suppose we did retain everything that we ever experienced with equal facility. We should remember every telephone number we ever looked up. We should remember all the irrelevant things that we had ever experienced and such memories would simply be a continual source of interference. What makes our memories of value is that we forget some things. The good memory is the selective memory. Fortunate is the man who can remember the things that will be to his advantage in later life, and who can readily forget the things that will be a hindrance.

What are the things that we want our memory to do? — The serviceable memory is the one that does the thing we want it to do when we want it done. At different times and under different circumstances, we impose quite different tasks upon it and it rises remarkably to the occasion.

1. *Immediate memory.* — Sometimes we want to remember a thing for a short time and then forget it. This is the thing we demand of our memory when we want to look up a reference. We discover that the information we need is to be found in a certain book on page 252. We

remember the name of the book and the page number long enough to find the reference. After that we care no more about page 252 and immediately forget it. Ask us five minutes later what that page was and we are not apt to know. We look up a telephone number and forget it. We write a business letter and immediately afterward forget the address to which we sent the letter. It was a valuable thing to be able to remember it long enough to get it written ; to remember it later would be a hindrance. It is in immediate memory that forgetting is even more important than memorizing.

2. *Rote memory.* — Sometimes we wish to remember a thing for the time being and for a specific purpose. After that purpose is accomplished we have little or no use for the thing. This group includes such things as parts in a play. After the play is over we have little use for what we learned and it soon fades away. Sometimes students regard the material that they have to learn to pass a course of study as belonging to this group. It is quite evident that insofar as this opinion holds, the permanent value of what is learned in the course is rather slight. The more prevalent opinion is that studies should fall in the next group.

3. *Associative memory.* — Association means neural connection and every neural connection produces a significant relationship between the connected elements. Associative memory, therefore, is the type that has many relationships, the relationships being, of course, with other things in our mental lives. Things that are useful we want connected with as many other things in our mental lives as we can possibly have. A useful citizen is one who not only has his personal family relationships.

He belongs to various civic organizations. He has made lots of friends. Whenever something needs to be done his friends know they can depend upon him. They always fall back upon him in cases of necessity. Good memories are like good citizens. They are always "on tap" because they have become related to so many other mental processes. Hence, the type of thing that we know we will have much use for should not be memorized as an isolated fact. It should be learned in its relationships to other things. The more the relationships, the more valuable the memory will be. We have already learned that the keynote of mental life is relationship, what we have called integration, between different parts. The function of the synapse we have learned is to provide for a multiplicity of connections. Associative memory is the type which makes the greatest use of multiple connections. Hence, never learn by rote that for which you know you will have great use. Learn it by connecting it with as many other things as you can.

For example, suppose you are told that iron comes from a kind of stone that is found in the earth. You memorize this and that is all you know about iron. What good is it? I ask you, "What is iron?" You reply, "I know, it comes from the ground." Iron is of little significance to you if that is all the meaning it acquires. But you learn a hundred other things about iron, how it is mined, the process by which it is extracted from the ore, how it can be wrought, cast into molds, made into steel, mixed with other minerals, how much stress it can stand, and other similar things. It assumes a richness it never would have by any system of rote memory. The value of these things is not that they have been remembered but that they

have been related. Wealth of memory lies in richness of relationships and not in the number of unrelated things that one has committed to memory.

4. *Recall memory.* — There are some things we want to remember so well that we will never forget them, that will come at our bidding as readily as we recall our own name. The basic things in education are of this sort, such as number sequences, the multiplication table, how to spell words, and other things of like order. That does not mean that these things should not have relationships of a rich sort. It means in addition that they should be fixed so thoroughly that they come back to us with no effort at all on our part.

5. *Recognition memory.* — There are other things that it is not necessary for us to know in detail, but which should be so familiar to us that we recognize them when we come into contact with them. When we find our way around a city, we use recognition. We are thoroughly familiar with a certain street and do not get lost. But let us try to describe in detail just what is on that street or just how the buildings look and we will make gross mistakes. Here recall of details is unnecessary. We simply need to recognize the things as we meet them.

It must not be thought that these distinctions are mutually exclusive. In each specific instance there are probably elements of more than one type but usually one predominates. Some of these methods require much less time and energy than others and at the same time some are less efficient than others. The thing we need to do in each case is to determine just what the end in view may be and adapt our memory methods best to meet our requirements.

Before taking up the different methods to be used, it may be well to get clearly in mind what we are trying to do when we attempt to improve our memories.

Retentivity. — *Memory depends upon the ability of the nervous system to retain any modification which it undergoes.* This we call *retentivity.* People vary in this capacity and individuals differ at various periods of their lives. From all evidence this quality is not improved or modified by training. You can not by training make an old man have better retentivity. One who is born with an inability to retain, probably keeps that weakness. The problem of memory training is not to enable us to change this characteristic of our nervous system but to enable us to use more efficiently the capacity that we do possess. It is possible to have a very fine tool, made of the best steel, and not know how to use it. On the other hand, one may have an inferior tool and gain great skill in its manipulation. A good artisan can do better work if he has a good tool but a good tool does not make a good artisan. It is the same with memory. We may have a wonderful memory capacity and use it very inefficiently. On the other hand, if our ability to retain is not as great as that of some other person, that does not mean that we can not gain great skill in the use of what we do possess.

This is emphasized in order to impress the fact that memory training is not like muscle training. You can make a muscle develop by any kind of use. Memory is not helped by any kind of exercise. It is not a matter of how much you use your memory, but how you use it that counts in the end.

We shall take up in turn the different methods that will help in gaining skill according to the purpose to which we

wish to place our memory. These methods will follow the types of purpose that we have just outlined. We shall take up first the facts of immediate memory, then study methods to be used where permanent recall is to be emphasized, then accurate recall for some immediate end, then associative memory, and finally recognition.

Immediate Memory

Immediate memory is fleeting and it is well that it should be so. The purpose behind immediate memory is a temporary retention leading to almost immediate reproduction. It would be inefficient and useless to attempt to burden our minds with a lot of irrelevant details that have no value for us except for some immediate need. Hence, to attempt to train our memories so that we can retain irrelevant things for a long time is a futile pursuit.

A number of memory fakirs do just this thing and we are impressed with their skill. They will repeat once a list of fifty or so words that have been given them and then reproduce them to an amazed audience. Such a performance is about the only value of such a memory feat. Do not look on such a performer with jealous eyes and take a memory course so as to be able to imitate him. It would pay to put your time to better advantage, for such a memory trick has little value in actual life.

It is possible, on the other hand, to have a memory so fleeting that one can not even remember a telephone number long enough to give it to the operator. Such a lack is probably nothing more than the result of lack of attention. If one looks up a number but at the same time is thinking intently about what he is going to say to the person he intends to call, it is very likely that the

number will slip from him. Such a memory slip should be no cause for concern. It is quite likely that the interest in the pending conversation is a very natural one and it has a perfect right to crowd out interest in a mere telephone number.

Interest is a very important factor in immediate memory. — A number merely as a number has no interest and will soon vanish. A number representing the number of a person in whom you happen to be very much interested may only have to be heard once to be remembered accurately for an indefinite period of time. In the last analysis it is always interest of some sort that takes memory from the immediate memory class and puts it in the group of permanent memories.

Memory span is the term used to indicate the amount of material one can reproduce after seeing or hearing it once. This span increases with years until we reach adult life, when it remains stationary till the deterioration of old age sets in. This memory span differs with different types of material. For example, an individual who can repeat six digits, such as 374859, after one hearing, can repeat twenty syllables in the form of a connected sentence, such as "The apple tree makes a cool pleasant shade on the ground where the children are playing."

How this ability increases with years is shown below:

The Average Child Aged:	Can Repeat:	Can Repeat:
3 years . .	3 digits, or . .	6 syllables in a sentence.
4 years . .	4 digits, or . .	12 syllables in a sentence.
6 years . .	. . . .	16 syllables in a sentence.
7 years . .	5 digits, or . .	18 syllables in a sentence.
10 years . .	6 digits, or . .	20 syllables in a sentence.
14 years . .	7 digits, or . .	24 syllables in a sentence.
16 years . .	. . . .	28 syllables in a sentence.

This comparison between the memory span for digits and sense material furnishes us the clew which should guide us if we wish to improve our immediate memory. We improve immediate memory by any device that will lend meaning to the material we wish to remember.

For example, suppose someone should repeat to you the following series of digits: 7236149258. It would be almost impossible for you to repeat the ten digits because they have no meaning. Suppose you analyze them as follows: 72, 36 (is one half of 72); 1492 (the year Columbus discovered America); 5 (three more than 2, the preceding digit); and 8 (three more than 5, the preceding digit). Now instead of trying to remember the whole series you remember the first two digits, one half of that, the year Columbus discovered America, and add three twice. The result is 72 36 1492 5 8. Of course, the value of such a scheme decreases in proportion to its complexity. The example given is about as complex as one would want to use. If a simple relationship is easily apparent it is useful. If one has to labor to get some complicated relationship it is valueless.

A mere grouping of the material will make it easier to reproduce. — For example, if the above digits are grouped 723 614 925 8; or 7236 1492 58; or 723 61 492 58, they can be more easily reproduced than if not grouped. The reason is that each grouping becomes a unit. Instead of ten units you have reduced the number to three or four.

The last grouping given brings in the factor of rhythm. It has been found that a rhythmic grouping is usually more effective than one that does not have rhythm. The first one for example has three groups of three and then one left over. Such a grouping is not as effective as the

last one, where you have a three and two then another three and two. The last one can be sung off and reproduced easily. It resolves into two beats with a long and a short foot in each.

These facts have a practical bearing in such use of numbers as in car licenses or in telephone numbers. When you get car license numbers in the millions you have a larger series of digits than one can grasp readily or retain easily. Hence other devices are adopted, such as 3–472–389, or B 472–389. In the use of telephone numbers, instead of having seven digits in a series such as 4327115, which would be very confusing, the letters of the exchange are substituted for the first three and the number becomes MONroe 7115. The second has the same selective value as the first and is much more easily reproduced.

All this goes to show that one does not need to attempt to increase the actual amount of material he can immediately reproduce after one hearing. What he should do is to attempt to use devices that will give meaning or relationships to the different parts, and thus increase his immediate memory span.

Rote Memory

Learning by repetition. — Everyone can easily demonstrate the fact that if a thing is repeated often enough, he will learn it. This learning will take place even though the repeated material is absolutely lacking in interest, is not related to other things in the person's life, and if no effort is made to learn. Such learning is not the best method to use, for it is very inefficient, but it is well to know the laws that govern memory in this simple form and then we can study the other factors that may fur-

nish an improvement in other forms than simple rote memory.

Simple rote memory of this sort involves the same learning mechanism that has already been described as the conditioned reflex. In a conditioned reflex we found that if you whistle at the same time that you offer a dog a piece of meat, he will learn to connect the whistle with the meat and will give you his attention and run toward you when you whistle. The connecting of the whistle with the satisfaction obtained from the food was a simple rote connection — the giving of meaning to something which before had no meaning.

Rote memory operates upon the same principle. The very fact that two meaningless things come in succession to attention gives them a neural connection. This nervous connection we describe by saying that we have learned or memorized the factors involved.

Thus, we wish the child to learn that C–A–T spells *cat*. There is no logical reason why these letters should spell an animal we have learned to know. If we could invent some logical reason our memory would be assisted. This is often done and will be taken up in a later section. But we can learn that C–A–T spells cat by a mere repetition of the letters and the word.

Even nonsense syllables, which have no meaning, can be learned by mere repetition. Take such a series of syllables as the following: *wok pam sut bip seg ron taz vis lub mer koj yad.* This list of twelve meaningless syllables can be memorized by repeating them over and over. After one has learned them, they may still have as little meaning as they had at first. If meaning is read into them, they can be learned more readily, but it is

possible to learn them although they have no meaning. Meaning is not essential to memory. All that is necessary is a neural connection.

Laws of memorizing. — Much has been learned about memory by practicing on just such meaningless lists of nonsense syllables, and the facts so learned can be carried over to the memorizing of other types of things. Let us examine some of these laws of memorizing.

1. *The ends of a list of items to be memorized are more easily learned than the middle of the list.* — The obvious lesson from this is that if one has to learn a list of things it will pay to put more work upon the middle section of the list in order to equalize the memory value of each part.

2. *Do not divide material to be learned into stanzas or sections.* — Learn it as a whole. It seems easier at first to divide it, but in the end more work is required when this method is adopted. If you have ever heard anyone forget when reciting a poem, it is usually at the beginning of a stanza. The reason for this is that he learned each stanza separately and then had to learn to join them together. This requires much more time than would have been the case had he learned it as a whole, and besides furnishes many weak spots. Repeating undivided material may make one feel that at first he is making no progress in the learning, but after the method has been tried several times this feeling will disappear.

3. *Frequent repetitions in the form of recitation are essential to efficient memorizing.* — One can read the material with his copy before him but attempted recitations serve to fix the material much more rapidly than many simple readings. Of course if one recites aloud, it is better than reciting mentally but in certain circumstances,

where audible recitation is out of the question, mental recitation serves almost as well.

4. *Frequent rest periods aid in memorizing.* — In our effort to put persistent effort into our work, we are very likely to attempt to adhere strictly to our task when we have some material to memorize by rote. It can easily be proved, however, that this is not the most efficient way to memorize. For example, one individual in the laboratory went through a list of twenty numbers with only thirty seconds between readings. Memorizing in this manner it took eleven readings before he could repeat all twenty numbers without error. Studying a similar list with five minutes between readings, he mastered the list in six readings. With an interval between readings of ten minutes, the number of readings was reduced to five. This number of repetitions was required with increased intervals between readings up to two days.

The obvious lesson from this is, that if you have a poem or a play to learn, it will pay to permit an interval to elapse between readings. Of course this can not be done if one puts off learning the assignment until the last moment. If you wish to save yourself work, begin early to learn the material and permit time to elapse between each reading. The interval may be five or ten minutes or even a day depending upon circumstances.

Another advantage of resting frequently is that the material once learned is more likely to be retained. Cramming may enable one to reproduce material immediately but the lasting value of such memorizing is very small.

In saying that one should rest between repetitions we do not mean that one has to do nothing in the interval.

It has been found that other work done in the periods between repetitions has very little or no effect on the memorizing process. This being the case, one should have various tasks to which one can shift. In other words, instead of resting in the sense of idling, one rests by changing one's task. In this way one can effectively be occupied with continuous work during the time one has for study and at the same time get the advantage of the rest periods between repetitions of the same material.

Finally, in connection with rote memory it should be clearly understood that, while sometimes we are forced to memorize in this manner, it is the least efficient of any type of memorizing. It should be supplanted wherever possible by other methods. Even though this is the case, one can carry over what has been found by the study of pure rote memory to memorizing of other types. In any case it will be found to pay to study material as a whole rather than to divide it, to recite frequently although recitation is not so important where material has meaning, and to permit intervals of time to elapse between the different repetitions of any type of material that is to be learned.

Associative Memory

Associative memory is the type of memory that stresses numerous relationships. — In rote memory the relationship is established between each part and its predecessor and successor in the list that is being studied. In such memory the connections are very narrow. If I study so that I can repeat the three nonsense syllables, *bop vix lup,* the only associations that are formed are a straight line relationship between the different members of the

series. If I study the list — boy, girl, mother — I not only have a direct connection between each of the members of the list but each element has other connections already established in my mental life. These connections we call meaning. By meaning we understand that in our past experience the words have been learned in other connections.

Hence, associative memory is that memory which is designed to enrich the associations, or relations, that facts in our experience may have. This is the most valuable phase of our memory, for when we want to use some of our mental attainments we can do it only by reviving relationships that have been established. A good memory is one that has a great wealth of associations, or meanings, connected with all its experiences.

There are two general ways in which associative memory may be cultivated.

(1) *Search for natural associations in everything learned.* This is the better method. Each relationship enriches a mental fact, makes it easier to recall when needed, and gives it added interest.

(2) *Invent artificial associations designed to aid recall.* The latter method may be of value for the immediate use but when the artificial scheme goes then the memory goes with the scheme. An artificial scheme may have a fairly close relationship to the material to be learned and in this case may have a real value.

A valuable use of associative memory is the following: A boy was having a hard time learning his multiplication tables. His method was rote memory. He was saying them over and over till he remembered them. When he got to the nines he was pretty well discouraged and could

not seem to learn them. To this boy it was explained that if you multiply nine by any number of one digit, the product would begin with one less than the number by which you multiply and the second digit of the product would be the difference between nine and the first number. These facts were demonstrated in a table arranged as follows:

$9 \times 1 = 9$	
$9 \times 2 = 18$	$1 + 8 = 9$
$9 \times 3 = 27$	$2 + 7 = 9$
$9 \times 4 = 36$	$3 + 6 = 9$
$9 \times 5 = 45$	$4 + 5 = 9$
$9 \times 6 = 54$	$5 + 4 = 9$
$9 \times 7 = 63$	$6 + 3 = 9$
$9 \times 8 = 72$	$7 + 2 = 9$
$9 \times 9 = 81$	$8 + 1 = 9$

With this scheme mastered, rote memory was no longer needed and the boy learned his nines in about five minutes and never forgot them.

This shows that memory for significant relationships is a very easily acquired form of memorizing and that it leads to great efficiency in mental life. One who learns meanings makes much more valuable use of his memory than one who fills his mind with a lot of unrelated or poorly related facts. We often get the erroneous idea that memory should serve to make an encyclopedia of our minds. We can not emphasize strongly enough the principle of associative memory. Learn relationships, not disconnected facts.

The association does not need to be a logical one. A common sense scheme is to relate them in the form of a verse with rhythm and rhyme. This is illustrated in a common way devised for remembering the number of days in the different months. Suppose we tried to remember

the days in each month as twelve disconnected facts. It would take considerable time and we should easily forget. Arrange the material in the following form and it is readily learned and likely to be retained:

> Thirty days has September,
> April, June, and November,
> All the rest have thirty-one,
> Excepting February alone,
> To which they twenty-eight assign,
> Till leap year gives it twenty-nine.

An illustration of a loosely related association scheme, and consequently a practically valueless one, is that of a man putting a piece of string around his finger to remind him to bring some meat home for dinner. There is no relation between a string around one's finger and meat. When he starts home he may notice the string but he is very likely to forget what the string was to recall.

Avoid artificial schemes, where the scheme has no meaning in itself. — Remember that a memory device is simply a way of giving meaning to memory material. If the device is more meaningless than the things to be remembered, it is worse than useless. The device should be one that is naturally suggested by the things to be memorized, in order that it will lead naturally to recall.

Emphasize the practical significance of memory material. — We learn things to help us solve some problems of life. The problems may not be immediate. We may not see all the possible ways in which what we are learning will be a help. But if when learning we can stress the value in solving simple problems that are at hand, it will lend interest to what we are learning and will give us the right attitude toward it.

Recall

The value of recall. — Recall is extremely vital in our mental lives. It furnishes the basis for all our thinking. We have been studying how things become fixed in our mental lives, but all these things have no value unless they can be produced and made to serve us at the right time. We have said that an efficient memory is one that discriminates in the material that is revived. Valuable recall does not mean indiscriminate recall, but recall of a highly selective sort.

Try to think how much of what you do depends upon recall and you will be amazed. We do not spend our time trying to remember facts during our ordinary life but the smooth progress of our thoughts and actions involves this process just the same. Every word that you use involves recall. When you perform any act, it is due to the fact that you have learned how to do it and are now reproducing it in your present activity. When you perform the slightest calculation, it means recall of your multiplication table and of other number relationships. When you meet a new situation that must be solved, you can only proceed as you recall those things you have learned that have a bearing on its solution. The efficient man in any line, be it in actual motor work or in thinking, is the one who, from things that he has learned, can draw the right thing at the right time. If you think of the right thing too late to make use of it, you are inefficient. If you think of the wrong thing, if your relationships are confused, your value is impaired. Is it any wonder that those who have fake memory schemes to sell, appeal to the public with the picture of a man pulling his hair as though

in great anguish and saying, "I forgot"? All our education depends for its functioning upon the process of recall.

The fundamental fact to be remembered, a fact which is back of all recall, is that it always depends upon the process of association. This means that some nerve current takes the same course through the nervous system that it did at some previous time. What does this mean in terms of response to some present situation? Two things are involved. First, there must be the possibility of revival in the nervous system; and second, there must be something in the present situation to stimulate recall.

What can be the causes for forgetting? — We will consider four specific causes.

1. *The associative bond may not have been well fixed.* — A boy may study a new lesson but little and come to class to recite. Being called upon, he gives as an excuse that he forgot. He forgot because he never learned adequately. At least, in most such instances this is the main cause, although the other causes to be mentioned might enter into this situation.

2. *There may be no stimulus adequate to revive the impression that has been adequately fixed.* It is this fact which gives rise to the notion that we have a vast storehouse of memories and that the main job is to keep it filled up. Our nervous system should be likened not to a storehouse but an intricate system of roadways. The only function of a roadway is to provide means of travel and intercommunication. We could have wonderful roads, but if they were not interconnected so that one might go from one to the other, they would be of no value. If they were properly connected and we had no individuals

trying to get from place to place on them, they would of course not be used. So, with our memories all in fine shape we still need the stimulus to "arrive somewhere" mentally in order to stimulate recall.

3. *Recall may be blocked.* — If we have memory traces well established in the nervous system and there is proper incentive to traverse these pathways, there is the possibility of a blocking of some sort. We may have a "traffic jam" in our mental lives and this is one of the most important causes for lack of proper recall.

Of course a traffic jam may be caused by a break in the roadway. So in our mental life, if for any reason there is an injury to the nerve tissue, certain pathways will be broken and recall that involves these will be checked. We are not primarily concerned with this type of forgetting. This is a problem in nervous disease. We are concerned here with those types of blocking of recall pathways that come from causes other than the injury of nerve tissue.

This "blocking" in recall is the more interesting because it is not understood very well and leads to so many peculiar situations. We know the name of a person perfectly well, but at the most critical moment we can not recall it. We are well prepared to give a recitation and when we get on our feet it all goes. We plan to do something at a particular time and then forget all about it.

Let us take a simple case first. It is in the forenoon. I meet a friend in school and he asks me if I will lend him some papers that I have. I tell him that I will be glad to do so and will bring them to school with me after lunch. The bargain is made and I decide to remember to get them at noon when I am home. No more is said to him but in my mind I plan some details that will help me to

keep my promise. I remember that I drove to school to-day and so I can bring the papers in the car. They are rather heavy and I think how fortunate it is that it will all work out so well. The next time the papers come to my mind is when I see my friend in the afternoon. My embarrassment is extreme for I wanted to lend him the papers and I am forced to apologize for my neglect. I explain to him that I wished to lend them to him. I am very sorry and can not understand why I forgot.

Why did I forget? As I go over the details of the incident this fact comes out. When I got home I found that my sister had arranged to use the car in the afternoon. She explains her plans to me and since I have only a few blocks to walk to school I plan to walk in the afternoon instead of riding. As I leave home I have a queer restless feeling as though I had forgotten something. I can not think what it is, I think probably it is because I am walking when I had thought of riding, and go on my way. This explains why I forgot. I had connected remembering my papers with riding to school in the afternoon. I changed my plans and walked and with this change I dropped from recall the things I had planned in connection with riding.

The principle that comes from such an incident may be explained as follows: *Planning details connected with recall will aid in recall but in such a case a change in plans will tend to block or make us forget all the incidents we had planned in connection with the original plans.*

On the other hand, when one starts to leave the house, or begins to do something, there may come a feeling of restlessness — a feeling that one has forgotten something. If one ignores this feeling, he is likely to discover at a

later time that he actually did forget something. This restlessness is due to the fact that when one plans to do a certain thing at a certain time he places his nervous system in what is called a "set." This is a condition of readiness which will lead one to do the thing at the time planned. The fact itself may be kept from coming to the surface but the restlessness is an indication that it is there. Usually it pays to heed rather than ignore such restless feelings. This does not mean that one should continually worry lest he has forgotten something. But when the feeling, "I have forgotten something," comes with intensity, it is usually indicative that one really has.

4. *An emotional disturbance is likely to cause forgetting.* We are all familiar with this type of forgetting in "stage fright." An actor may know his part perfectly but if when he gets on the stage he becomes panicky, it will vanish completely. One answer to this may be to learn the thing so completely that even intense fear will not block it. This is a hard task, however, for even extremely well-learned things will go if the proper emotion comes up. For instance we may have thoroughly learned how to handle things at a dinner table. Let us get into a strange situation where we are constrained and how prone we may be to spill something — just when we are trying to be at our best. The attempt to be at our best is the disturbing element. We are so anxious that we forget even well-organized motor habits and spill our soup or water. The real answer is to get control of our emotions.

Methods of recall. — While an intense emotion may block all recall a specific emotion may prevent recall of specific things with which it may be connected. Consequently, when one is unable to recall a thing he knows

perfectly well he should be able to recall, the trouble is very likely to be that the thing to be recalled has become connected with some emotional block or interference. The forms that such an interference may take will vary in each case and so any illustration will only apply to the case in question. With this warning in mind let us examine a few cases of failure to recall of this type.

1. *Forgetting the name of a person.* — Of course such forgetting may be due to the fact that we do not know the name very well. But where the name should be remembered, where it actually comes back afterwards, it must be due to some interference. Various types of interference may cause such forgetting. The person may resemble someone we do not like. The name may be the name of someone we have been trying to forget. In such a case we are trying to recall a thing which is related in our minds with something we are trying to forget. We are really trying to do two opposite things at the same time — to forget and to remember. The way to overcome such forgetting is to disconnect the material we wish to remember from its relationship to that which we wish to forget.

2. *Do not try to forget the unpleasant.* — This type of forgetting may assume undue importance in our mental lives if we place too much emphasis upon our attempts to forget the unpleasant or undesirable. Very early in our lives we learn that it pays at times to forget. The most acute mental suffering may be relieved if we can but forget. We even learn to use this lack of memory to cover up moral lapses. If we have failed to do a thing we promised, we seemingly can evade responsibility by the silly excuse, "I forgot."

The best way to forget the unpleasant things in life is not to attempt to forget them. If we attempt to get rid of them by forgetting, it usually means that we have a fear of facing them. Such a fear may keep them from coming to our attention — we block the traffic against them. It does not eliminate the tendency formed in the nervous system for the memory trace to be existent and active attempts to forget usually make the memory the more alive. Hence, to keep it down we must continually increase the energy of resistance. The best way is to face the thing, whatever it is. This frank review — to ourselves — of unpleasant or undesirable things removes our fear of them. We find they are not as horrible as we supposed and we can let them drift just as any unexercised memory will lapse. Unpleasant things faced squarely will be forgotten more quickly than if we fearfully try to forget them.

Even though we follow the method outlined to keep our memories free from unpleasant emotional relationships, there will be a certain number of such connections in spite of all we can do. How can we recall in spite of such factors?

3. *The best way to recall a thing which seems to elude one is to relax and give up all attempts to recall.* — Following such a method we shall find that after a time the desired item will "pop" up. If we say we will not give up, and fight to get the elusive fact, we shall find that it will not come. We have all had such an experience. After trying vainly for a long time to recall a thing we at last say, "Well, I give up." Then after we have confessed defeat it comes bobbing up. This should not be a cause for rebuking ourselves for not adhering to the task. We did the right thing to give up. The reason for this is

that the harder we fight to recall a thing the greater the emotional tension that will be shown and since it is an emotional factor that is blocking the memory this simply makes it harder. Relax, and the emotional life will subside, the reason for the blocking will go, and we may recall.

This works in general and specific recall. The way to pass a good examination is to get thoroughly relaxed before taking it. Most students do not. They study hard up to the minute of the examination and go to the ordeal filled with a fear that they will forget. After they have studied so hard, they find that it all seems to leave them and that an hour after the examination they think of all the answers. Of course if you know nothing about the subject, relaxation will not bring it out; but fear will not help to bring out what may be there. Students often pray feverishly for help, the fear being evident in the form of their petition. A sample of this recurs to the writer. We used to go to examinations saying:

> Oh! Lord of Hosts be with us yet.
> Lest we forget. Lest we forget.

Then we would come from the examination saying:

> The Lord of Hosts was with us not.
> For we forgot. For we forgot.

Nothing will block an association pathway as much as an emotion, especially the emotion of fear. The way to recall is to keep the pathways clear. The way to keep them clear and recall is to relax.

Recognition Memory

You often hear people say, "I can remember faces but I cannot remember names." The two are quite different. Recalling faces is recognition memory, while

remembering names means recall. Recognition is much easier and much simpler as a psychological process than is recall. All that is involved in recognition is a feeling of familiarity. Recall means not only that there should be a feeling of familiarity but that the former experience be reproduced.

It can be easily demonstrated that recognition is an easier process than recall. Show a person 25 cards each having typewritten upon it the name of some well-known city. After you have shown the whole series one at a time at about the rate of one each ten seconds, ask the person to tell you the names of all the cities he remembers having seen on the cards. This is recall. After he has recalled all he can, mix up the twenty-five cards with twenty-five others having on them the names of other cities not too different in familiarity from those shown the first time. Now let the person go through the pack of fifty cards and sort out the ones that he recognizes as having been shown to him before. It will be found that he can recognize more than he could recall. So the one who defends his poor memory by the excuse that his recognition is better than recall is stating a fact that is true about everybody. It is a very poor excuse and defense of his poor ability to recall.

The value of recognition lies in the fact that it enables us to orient ourselves in situations which are somewhat familiar without our going to all the trouble to reproduce irrelevant details.

QUESTIONS

1. What sort of things are most worth remembering?
2. Give an example from your own experience to illustrate each kind of memory.

3. How may we improve our memory?
4. Criticize the ordinary "patent" memory courses.
5. Show the relation between memory and interest.
6. Have someone read the following series of numbers to you or you read the series to someone else at the rate of one digit per second:

285	3725492
4537	53268473
38265	732547658
624739	2931762475

The memory span may be considered as the number of digits in the last number in which all the digits are repeated and in the correct order. Compare the scores for different people on this experiment.

7. Construct a similar experiment using letters instead of figures. Compare the results with the use of the letters with the results obtained with the figures. Give some possible explanations for the difference in results if there be a difference.
8. Why does grouping aid in memorizing?
9. Why can the average ten year old child recall twenty syllables in a sentence and only six digits?
10. How does rote memory differ from associative memory? Of the two which is the more rapid? Give the reasons for the difference.
11. State the four laws of memorizing.
12. Which one of these laws justifies frequent reviews in studying?
13. What is an artificial memory device? When should such a device be used?
14. Why do we forget?
15. If you can not remember the name of your first high school teacher how would you go about trying to recall it?
16. What effect will getting worried over an examination have upon the results of the examination?
17. Why do most of us remember people's faces better than we remember their names?

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CHAPTER XI

FEELINGS AND EMOTIONS

The Nature of Feelings and Emotions

John Smith is pitcher for the Brownville High School in a game against the Big Rock High School. It is the first half of the ninth inning with Brownville High School leading 4 to 3 and Big Rock at the bat. One man has hit safely and is at first. The second man up has two strikes and three balls. John pitches a ball that he claims cut the corner of the plate. The batter did not strike and the umpire calls it a ball. We will not write down what John thought or what his team mates and rooters said to the umpire.

John Smith then and there developed a first-class emotion of anger. So did most of the other members of John's high school. On the other hand the Big Rock fans were just as happy as John and his upholders were angry. This is an example of where one and the same situation caused exactly the opposite emotion in the two groups of people present. In other situations in life all

present may be affected in the same way. All the passengers may be frightened when two railroad trains crash together. From these facts it may be seen that emotions are primarily dependent upon the make-up of the individual rather than upon external situations. Emotions are the most individual things in our lives.

The real core of the emotions is the feelings. — There seem to be only two primary feelings, the feeling of pleasantness and the feeling of unpleasantness. Feelings are elementary states and exist to some degree at all times. They accompany all sensory impressions, so that each sense impression may be said to have a feeling tone which may range from an extremely pleasant to an extremely unpleasant sort or fall at any point between these two extremes. For example, in Figure 51 there are five geometrical figures. None of these will arouse any profound feeling but you will be able to select the one that you like best and the one that you like least. If you ask a number of persons to make similar selections, you will find a certain degree of uniformity, although there will be individual variations.

Since each sense impression has a particular feeling tone and since we are continually receiving impressions from all sense spheres, our feeling at any one moment may be rather complex. We may see a beautiful desk with a big scratch across it. The desk arouses a pleasant feeling while the scratch arouses an unpleasant one. We may hear music and harsh noises at the same time. The hard seat of a chair may be causing us tactual unpleasantness, while the fur collar around our neck may be very pleasant. Our shoes may be too tight, while we have the feeling of pleasantness that results from a full meal.

In spite of this possible complexity, feelings are elementary and do not produce any violent reactions on our part. We are able to keep our composure in the presence of all these varied feelings. When we are aroused to such an extent that our composure is threatened, we no longer have feelings but emotions.

Emotions and the autonomic nervous system. — An emotion may be described as a stirred-up state of the individual. This stirred-up condition is not a haphazard affair, but is under the control of the autonomic nervous system. This part of our nervous system was mentioned in Chapter II. This system is much older and found in animals much lower down the animal scale than is the central nervous system. Earthworms have an autonomic system but only the rudiments of a central system. Each segment of the earthworm has its own section of the autonomic system. In man both the central nervous system and the autonomic nervous system are found side by side. They are semi-independent of each other but connected in places.

The autonomic system in man is divided into three main parts. One part is located mostly in the head and called the cranial (head) section. One part is located mostly in the chest and is called the thoracic section. The third section is located in the lower abdomen and is called the sacral section. These three seem to work in more or less diverse ways.

As far as we can discover it is believed that the autonomic nervous system is the coördinating force in our emotional lives. It takes different activities and unites them into the complex group that we all recognize as expressing different emotions. Let us see how this takes place.

The simple emotions. — 1. *Fear.* — If a sudden loud sound, such as a heavy peal of thunder, strikes our ears, a nervous current is carried to the brain. Part of this current goes out to the muscles of the body and we jump. This is a reflex response of the sort we have already studied. Part of the current goes to the autonomic nervous system, probably to the thoracic section, which seems to be most affected by the fear stimulus. This current divides and does a number of things. (*a*) Part goes to the heart and the heart beats faster. (*b*) Part goes to the stomach and intestines and their activity (called peristalsis) is checked. This is the basis for the peculiar hollow feeling in the stomach region following a sudden scare. (*c*) Part of the current goes to the capillaries of the face and they are contracted. This causes us to look pale. (*d*) Part goes to the muscles of the hairs of the body and our hair literally stands on end. (*e*) Another part stimulates the liver so that it sends out glycogen, a food product, through the blood to the muscles of the body. This makes the body ready so that if there is any running to be done, the body will be in good condition to run. (*f*) Finally, a part of this nervous current may run to the adrenal glands, two small bodies, one over each kidney. These glands secrete a small amount of fluid called *adrenalin.* This adrenalin is carried to all parts of the body and acts as an immediate stimulant. It is the presence of adrenalin in the body that permits us to perform seemingly superhuman acts when badly frightened or when angry.

2. *Anger.* — Anger is another emotion that is very closely related to fear. The visceral parts of the emotions are much the same. The bodily side is different. In fear, the bodily attitude is likely to be that of withdrawal.

The person tries or considers escape. In anger, the bodily attitude is just the opposite. The body assumes an aggressive attitude. Fear and anger may be regarded as complementary. Faced by a harmful situation a person may fear and attempt to escape, he may become angry and begin to fight, or he may alternate between the two.

3. *Joy.* — Joy is quite a different emotion. You have just received a grade in a course in which you were afraid you had not done so well and you find that your grade is an A. This is just cause for joy. There is the general bodily attitude and facial expression that is not hard to detect. You stand a little more erect, the chest is thrown forward, the corners of the mouth turn up at a slightly greater angle. There is a general heightened tension (called tonus) of the entire body. This combination of activities is also due to coördinated impulses from the autonomic nervous system.

4. *Sorrow.* Sorrow is the converse or complement of joy. Filled with sorrow, your reactions are the opposite of joyful responses. Instead of standing erect, you tend to droop. You retract your chest instead of throwing it out. Your mouth angles are turned down instead of up. There is a general relaxation of bodily tonus in place of the increased tonus (or tension) of joy. Joy is the emotion that results from a successful termination or progress in a situation and sorrow is the emotion that results from impending or actual failure. This success or failure is not based on the judgment of others but represents wholly the reaction of the person experiencing the emotion. What is success to one may be failure to another. The causes for sorrow to one individual may

produce joy in another. This emphasizes once more the individual character of emotional reactions.

5. *Love.* — Love or tender emotion is another emotion in which the bodily response is of the positive sort. It is a response to a pet animal, a child, or some other person. The response may be one of fondling, keeping in the company of, or talking with the person loved. The internal or automatic responses are similar to those of joy.

6. *Hate.* — Hate is the opposite of love. Hate makes one withdraw from the presence of the hated person or object. While love is an expanding emotion, hate is a contracting defensive emotion. It makes one possessed with it guard himself from others and withdraw from them. Love and hate are so common to all of us that they need little elaboration to enable us to understand their workings.

Complex emotions. — The list of emotions thus far described may be called primary. But we may have these emotions combined. Jealousy, reverence, admiration, and revenge are words which describe complex emotional states. It is difficult to analyze these emotions. Reverence has been more or less successfully analyzed into love, wonder, and fear. Jealousy is probably a combination of love with fear and anger. However, to attempt to work out the components of each emotion is of little value. We must remember that the autonomic nervous system is a complex mechanism and that a vast number of coördinated responses are possible. Each separate coördination is really a separate emotion. They may be classified for convenience, but an analysis on the basis of such a classification is likely to produce an over-simplification.

Emotional swings. — Emotions are very mobile and unstable. It is essential, considering the nature of the function they serve, that this should be the case. When emotionally aroused one is stirred up because the ordinary reactions have not enabled one to make a satisfactory adjustment. When in a dilemma, a fixed emotion would be about as useless as no emotion at all.

Suppose you have been stung by a bee, great numbers of which are flying about you. Your first emotion may be one of anger — you feel as though you would like to kill those bees. But in an instant your anger turns to fear and you run as fast as you can. Fear has followed anger in the course of a few seconds.

Having escaped the bees you may feel elated for a time, until you recall that you are to be in a play to-night and discover that your eye is almost hidden by the swelling from the bee sting. Depression follows in an instant and you feel sure that you are the most unfortunate of mortals. You were depending so much on the results of your appearance in the play and now all that is gone. Joy and sorrow can replace each other as quickly as fear and anger.

In the same way love and hate can alternate. Having been stung by the bee and feeling depressed as a result, you are more than delighted to see your best friend approaching. Now you will have the pleasure of sympathy from one you love. This makes your reaction of love especially strong. To your amazement your friend, seeing your eye, throws back his head and laughs uproariously. What kind of a friend is this? Your love vanishes, at least temporarily, and you hate him.

A clear recognition of the fact of the mobility of the emotions is essential, if we are to understand the nature

of emotional life. The original response to a person, thing, or situation may not be any indication of what the final emotional attitude will be. If you are anxious to gain the good will of a person, some sort of an emotional reaction is a better omen than total indifference even though the emotion is not of the type that you wish. Have you ever noticed the antics a boy will perform in order to get a certain girl to respond? He will frighten her, distort his face so as to make her shriek in horror, or even tease her in order to make her angry. How can such antics win the affections of a girl? In his boyish way he is doing the essential thing. He is getting some sort of emotional response. This done, he can then take steps to convert it into the sort of emotion that he desires.

Emotional Development

We can best understand the importance of emotional development by asking ourselves a few questions. Of what value are emotions? Would we be better off if we did not have any emotional reactions, if in every situation we could act with extreme coolness and poise? Are some emotions more valuable to us than others? If so, how can we acquire the desirable ones and restrain the undesirable? Are we forever slaves of our emotions or can we make them our servants? Let us see whether we can answer some of these questions.

Attachment of emotions to external objects. — The process of the growth of the emotions is a very important problem. The small child innately responds in certain ways to, and has certain feelings toward, objects and people. He has some very decided likes and dislikes. Loud noises, sudden changes, and lack of support disturb the child.

He hates restraint in the sense that his motions are absolutely checked. Certain types of things inherently please him. He likes easy movements. He enjoys contact with his mother's arms. The mother soon learns what pleases her child and what does not. These innate likes and dislikes are not very numerous, but as the child grows in age and in experience, he learns to attach emotional values to most of the things in life.

The way in which these attachments take place is precisely that of the conditioned reflex explained in connection with reflex actions in Chapter III and illustrated in the salivary reflex of the dog being modified by a bell as shown in Figure 15.

A child is afraid of a loud sound but is not afraid of the dark. Permit the child to be frightened by a loud sound made when he is in the dark and he is very likely to associate the two and thereafter show a fear of the dark. If he learns that some person, a burglar, produced the sound, or if he hears a story about a burglar operating in the dark, the fear may then become connected with burglars. In this way the numerous fears of later life are formed. It is not the fear reaction that is different, but the nature and the number of situations and objects with which it has become connected.

The same thing is true of love and hate. The child, being made comfortable and contented through the ministrations of the mother and the nurse, tends to take on the expansive attitude of love in the presence of people. Let him be injured by a certain person in some way and he establishes a shrinking or hate reaction toward that person.

An emotional reaction of this sort will not only deter-

mine the attitude toward the person or thing originally arousing it, but will transfer itself readily to any person or situation that bears a resemblance to the original situation. On account of this fact a stranger often starts off with a decided handicap if he should happen to resemble in some characteristic someone that the child dislikes. This dislike may be based on some trivial look, action, or mannerism of the person. The child may not be able to explain why he does not like the newcomer — he simply does not. Sometimes the cause is known. For example, any girl by the name of "Nellie" has a serious handicap to overcome with the writer, because a girl by that name once sat back of him in school. The girl delighted in bothering him both in work and in play. She was larger and successfully "picked" on him all the way from whispering when he was not interested, to pulling his hair. Possibly if she had been good looking, even at that early age conditions would have been more in her favor. But she was not.[1] As a result of this experience any girl by the same name has to prove to the writer that she is not just another "Nellie" of his school-days before she has a fair start with him.

Joy and sorrow become attached to the various situations of life in the same manner. This growth takes place so continuously that we soon have some sort of emotional attitude toward all the things of life. No matter how simple or how complex the emotion may be, it is established through associations and the principle is the same as that of the conditioned reflex.

[1] It is quite likely that the persistent emotional antagonism of the writer for this girl has influenced his description of her at this late date. Things we like and persons we like are beautiful. Those that we hate are very often ugly to us.

These emotional attachments are very persistent, more so than any intellectual associations that may be formed. One has to study a long time to get such a connection as nine times nine are eighty-one. But one can get a permanent love or hate connection established by a very simple experience.

Emotional habits. — If it should happen that a person's experiences tend to produce repeatedly an emotion of a certain type, he may establish an emotional habit. Emotional habits have been variously named: attitudes, moods, temperaments, or sentiments. If one has been taught to hate rather than love he develops an *attitude* of hate which carries over into new situations. If an attitude is of short duration it is called a *mood*, unless it is very short and violent. In the latter case it would be called a *passion*. If the attitude is of long duration it is called a *temperament*. If of long duration and complex it is called a *sentiment*. Whether simple or complex, of short or long duration, their fundamental nature is the same. They are built up as habits and they color our responses when we face the various situations of life. Sometimes this coloring is to our interest and sometimes to our disadvantage. Some have healthy emotional habits and others have not. Much of life's sorrow is caused by emotional disturbances, traceable to unhealthy emotional habits.

Children differ in their innate emotional reactions. Some seem to be predisposed to instability, to bad tempers, and unusual fears. Others are pleasantly disposed toward the world and the people they meet. But on top of these inherent differences still greater ones are brought about through the training the child receives.

A child with an agreeable disposition may have one parent who arouses his fear. He may somehow have developed this fear early in life and the parent does things continually to antagonize him and arouse his dislikes. Somehow they never get along together. Confidences are never exchanged in later life. The other parent may be kind to the child and a fondness develops which grows into the closest ties of friendship and love. This parent is a real pal and confidant. There is no question in this case which parent will have the respect of the child. The problem is much more difficult when the child has a poor emotional background upon which to build. He may become upset emotionally over the slightest domestic friction. We have seen how closely related emotional responses are to the movements of the digestive organs. Emotional instability thus may lead to emotional indigestion as well as other disturbances of the vital organs. Hence you get organic complications built up on unsavory emotional training. From such homes come many of the misfits of life.

A similar condition to that in the home holds for the school and playground. The teacher, next after the parent, holds the favor or disfavor of the child. Some teachers are by nature fitted to win the respect of the child and to control and train his emotional life. Others are totally unfit for this work. It is well to understand that the emotional training is even more important for the child than intellectual training.

It must not be understood that emotional training should be founded upon a one-sided, easy-going policy on the part of the educator. Not every whim and wish of the child need be gratified in order to produce a proper

emotional balance. It is built rather upon a firm coöperative basis of give and take.

Not only does much of life's usual misery come from an unwholesome emotional life but many of life's more serious tragedies are based on emotional distortions and repulsions. There are over 300,000 people in hospitals for the insane in the United States and it is pretty well established that insanity is more often due to some disturbance in the emotional life than to any other cause.

If we could only develop a more healthy relation to others and to ourselves, how much better this world would be to live in! If human sorrow and worry — unnecessary sorrow and worry — could be reduced on the average an hour a day, what a difference it would make! Is this possible? It is. When parents and teachers learn how to train the emotional lives of children even as they now train their intellectual lives, much improvement will occur.

It is not to be inferred from what has just been said that there is no place for sorrow, fear, and anger in our lives. There are plenty of things that normally do and should cause fear. It is only the foolhardy that are without fear. We should fear real dangers and evils. Likewise there is occasionally a place for worry. Few of us are entirely free from causes for worry. But many times our worry is unfounded. Furthermore worry too often prevents us from doing our best even in those things about which we are worrying. The man who worries about the possibility of losing his job is thereby more likely to do poorly in his work and become more subject to dismissal. Anger is sometimes a virtue. The writer has never known a really worth-while individual who did not sometimes become angry. But some of us get angry

without cause. We thereby lower our efficiency and become a less valuable member of society.

But what can we who have formed bad emotional habits do about it? Are we tied to these habits for life? By no means. No more than we are tied to any other habit. The same rules apply here as apply to habit formation in general.

The difficulty in retraining our emotions comes from the fact that we have been taught wrong methods of control. We have grown up under the notion that emotions are degraded and that they should be suppressed. It is the attempt to restrain all emotional life that causes so much of the mental trouble referred to above. The task is not to suppress emotions but to direct them. Emotions are really the dynamic element in life. As such they are a tremendous force to make our lives or to wreck them. If we have a vast source of power, we can spend all our time trying to keep it from functioning for fear it might get the better of us. A better way is to study the nature of this energy and discover how it may be placed at our service. Controlled direction and not suppression is the keynote to the training of our emotions.

QUESTIONS

1. What are the primary feelings?
2. How would you demonstrate that simple sensory impressions produce a feeling tone?
3. Describe the relation of emotions to the autonomic nervous system.
4. How are feelings and emotions related? Distinguish between them.
5. Define an emotion.
6. Describe the three pairs of fundamental emotions.

7. Give some illustrations from your own experience to demonstrate the mobility of emotions.

8. Show how emotions become attached to external objects or persons.

9. Can you give any original evidence to show that emotional attachments are enduring? Give illustrations of both desirable and undesirable attachments.

10. Can you discover a way to overcome a strong fear?

11. Describe some different emotional habits.

12. What is meant by emotional training?

13. How would you go about correcting a bad emotional habit?

14. At various points throughout the text the influence of emotions on various mental functions has been brought out. Can you elaborate upon this subject and show how the different phases of mental life — attention, perception, memory, and effort are influenced by emotional habits?

15. In the first chapter the scientific attitude was discussed and contrasted with the attitude of superstition. What part does emotion play in the two attitudes?

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CHAPTER XII

EFFORT

Effort and Training

The success of an individual depends to a great extent upon his ability to meet difficult situations. — Some persons retire from every obstacle that they meet, others are stimulated by every difficulty to a greater effort to achieve the end which the interference threatens. We recognize very early in our lives that life means a struggle. Those who meet this struggle with zest have always won the approval and praise of their fellows. The dictionary is full of words that we use to describe the heroic individual and it is just as full of shameful terms which we apply to the coward.

As James [1] puts it: "We measure ourselves by many standards. Our strength and our intelligence, our wealth and even our good luck, are things which warm our heart

[1] *Psychology*, 1908 edition, pp. 458-9. Henry Holt & Co.

and make us feel ourselves a match for life. But deeper than all such things, and able to suffice unto itself without them is the sense of the amount of effort which we can put forth. Those are, after all, but effects, products, and reflections of the outer world within. But the effort seems to belong to an altogether different realm, as if it were the substantive thing which we *are*, and those were but externals which we *carry*. . . . When a dreadful object is presented, or when life as a whole turns up its dark abysses to our view, then the worthless ones among us lose their hold on the situation altogether, and either escape from its difficulties by averting their attention, or, if they cannot do that, collapse into yielding masses of plaintiveness and fear. The effort required for facing and consenting to such objects is beyond their power to make. But the heroic mind does differently. To it, too, the objects are sinister and dreadful, unwelcome, incompatible with wished-for things. But it can face them if necessary, without for that losing its hold upon the rest of life. The world thus finds in the heroic man its worthy match and mate; and the effort which he is able to put forth to hold himself erect and keep his heart unshaken is the direct measure of his worth and function in the game of human life. He can *stand* the Universe. . . . And hereby he makes himself one of the masters and lords of life. He must be counted with henceforth; he forms a part of human destiny. Neither in the theoretic nor in the practical sphere do we care for, or go for help to, those who have no head for risks, or sense for living on the perilous edge."

In all this it is not effort in itself that we admire but effort manifested in certain situations where we feel that

we would be tempted to yield. How do we develop the quality that we so glibly praise?

Innate background of effort. — The original background of effort is present in all of us at birth. Indeed, it is a fundamental trait of all living organisms. A tiny one-celled animal, such as the stentor, will show effort. The stentor is a trumpet-shaped animal, usually found attached by its stalk to some solid object in the water. If we continually force a jet of very weak chemical substance upon the stentor — weak enough not to be harmful unless applied for a long time — it shows a very interesting series of reactions. First, it may pay no heed to the jet of chemical substance. Then, it will turn slightly to one side to avoid it. Third, if this does not get it away from the jet, it will stop its normal eating movements and close up its trumpet-like opening. Fourth, if the jet still persists, it will let loose its hold on the solid object and swim away. So, even a one-celled animal shows the characteristics of heroic activity. It first resists the unpleasant situation with all the means it possesses for fighting and when all its powers fail, even then it does not give up, but uses its last means of defense, moving from the unpleasant environment.

No baby is a coward at birth. — Some are more active than others but all will fight if you hold their arms tightly to their sides. A baby will yell his disapproval where an adult would be afraid to open his mouth in the faintest whisper of protest. In a baby, opposition is an adequate stimulus to produce a fighting response. It depends upon the type of training the child has whether he continues to fight or whether he surrenders in later life.

What makes an heroic baby into an adult coward? If

every time the child fights opposition the opposition continues until he is defeated, he will learn that in this particular case fighting does no good. He will give in without fighting. A coward is the result of a series of experiences where the child has learned that he can not successfully oppose the stronger forces that he meets. If you should see a dog running along the street with its tail between its legs, exhibiting great fear whenever it meets any person and even yelping in fear if you should make a move toward it, you would infer at once, and correctly, that the dog has been abused. When you meet a human coward, you can infer with similar accuracy that he has been so thwarted in everything he has attempted, that he has lost his hold on life. Such a person, instead of deserving our scorn, deserves our sympathy. *Cowardice is a habit. It is the habit of failure.*

Courageous persistence, on the other hand, is the habit of success. It has an adequate foundation, as we have shown, in the innate possessions of the child. It is developed when the child learns that if he does not surrender he will be rewarded.

Proper training in effort. — Proper training in effort means teaching the child to get a proper balance between persistence in achieving his ends, and the control of some of his impulses. The well-trained individual is the one who persists in things that are for his ultimate benefit and gives up those things that would end in his injury should he persist. Thus, it appears that our praise of effort must be qualified. There is no real distinction between the stubborn individual and the persistent one, except in the end he seeks. He is regarded as persistent if we approve his conduct, stubborn if we do not.

1. *Controlling impulses.* We learn to control our impulses not by giving them up but by learning that it will pay to wait till some future time to get what we want, or by becoming convinced that some substitute is better. The method of delaying our enjoyment is the real background of persistence. This learning must take place gradually and follow the same course that all learning follows. The delay in the first place must not be too long. The child is taught to wait until mealtime for his food instead of eating every time he is hungry. He learns this lesson when he is convinced that he enjoys his meals more and feels better when he waits. If he waits merely because he is forced to do so, he has not learned the lesson. Persistence means controlling and delaying one's impulses. It never comes when one's conduct is forced upon him. Too often in our training we get the idea that as long as the end result is there everything necessary has been accomplished. This is not so. The training is not effective until one has an opportunity to do the thing at this moment but decides, without any constraint, to wait for the time being.

Honesty, thrift, neatness, and all the virtues must be built in this way. The child who has virtue thrust upon him is not virtuous. He waits the first opportunity when control from the outside is relaxed and shows his real personality. The boy who is honest because he is afraid of getting caught is controlled by fear. That is as far as some people ever get. The boy who has real honesty has it ingrained as a habit. It has been learned by a series of experiences so that now he does not get emotionally excited when a chance comes to steal. He has learned to put off possession until he has earned the thing he wants.

The secret of this control is not giving up, but putting off gratification. The unselfish person is not the one who has forever discarded selfishness. He is the one who has learned that he gets more pleasure from being generous than he does from being selfish.

2. *Choosing the difficult task.* — We often find a person who will not work at a given task. He will not study, he will not do anything that requires the least discomfort. He will start a new job with great enthusiasm but will immediately drop out when the first obstacle is reached. On the other hand there is the other type of person who will work with more enjoyment, the more difficulties he encounters.

One reason for laziness is that teachers emphasize the unpleasant part of work. They give the idea that anything that is pleasant is not work, that as soon as it becomes unpleasant it is work, but that in spite of these facts we should work.

The reason why one sticks at an unpleasant or a boresome task is that he hopes to accomplish something. The end, if vivid enough, irradiates the work, so that the work may become an integral part of the goal. In this way work becomes a pleasure.

This attitude is gained by learning. Begin some simple task with the goal not far distant, but so arranged that by a little painful work the end is achieved. By the mechanism of the conditioned reflex, the work — the process of getting the goal — becomes part of the goal. The reason we dislike work is that we make an end of it in itself. Work should never be an end in itself. It is always a means to an end. To encourage any one to work for work's sake is a mistake. A child will work harder at

some game than at anything else, but he does not regard it as work. The labor is part of the goal of the game. The one who is adjusted to this problem of life regards every task in this light. The goal may become farther and farther removed but the work is still a process in achievement. If this is not the case, it means that the goal has too suddenly been moved to too great a distance so that the worker fails to see the relation.

To sum up, effort is based on a primitive tendency to resist opposition. It takes various forms, according to the manner in which it is trained. It may enable one to make a moral choice or to persist in activity of an unpleasant sort, but in any case it is the habit of postponing gratification because we have learned that we get more in the end by so doing.

Effects of Work

Muscular fatigue. — Having found why we work, let us examine how work affects the individual. If a muscle is made to work steadily it will gradually become fatigued and eventually will refuse to respond at all. This has been shown in the laboratory by means of an apparatus called the *ergograph*. *Ergo* comes from the Greek word *ergon*, meaning work, and so this instrument is a machine to record graphically the work that a muscle or a group of muscles does (see Figure 66). Here a weight is attached to the muscle of one finger. If the finger is flexed the weight is lifted and the pointer at *p* moves along a smoked paper, thus making a mark. Figure 67 shows such a record when the contractions were made every two seconds. It can be seen that the extent of the movement gets shorter and shorter until after about forty-eight

pulls there is practically no response. This means that the muscle has spent its energy at a faster rate than it was able to accumulate fresh energy and has finally become bankrupt. A short period of rest will, however, enable the muscle to revive and it will be able to repeat the performance. If the rest period is not long enough, fatigue will come on sooner than the first time.

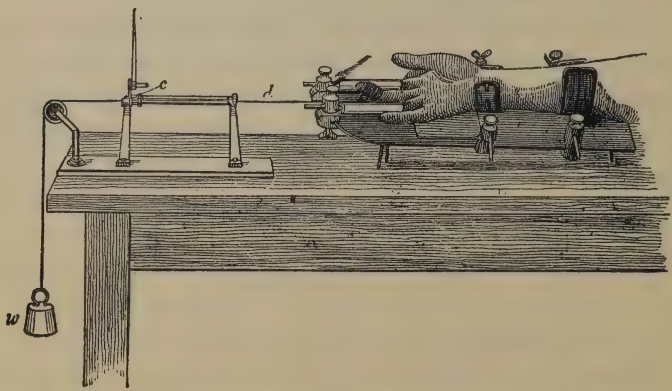

Fig. 66. — Instrument to Record Muscular Fatigue

c is the carriage moving to and fro on runners pulled by means of the cord *d*, *p* is the writing point which marks all movements on a smoked paper, *w* is the weight to be lifted. (From Howell, *Physiology*, W. B. Saunders Company)

It has been found that no serious harm comes from muscular fatigue of this sort unless carried to great excess. Exercise of a muscle produces certain waste products which have to be carried away: and nourishment has to be provided for recuperation.

Feelings of fatigue. — Along with fatigue goes a feeling of fatigue which is a sort of warning to the individual. If work is continued, this feeling is likely to pass off and one gets what he calls his "second wind."

The feeling of fatigue then seems to have no real relationship to the actual fatigue. The first onset of the feeling of fatigue may be very acute while the body is not nearly exhausted, while on the other hand when exhaustion is about complete the individual may have almost totally recovered from the feeling of fatigue.

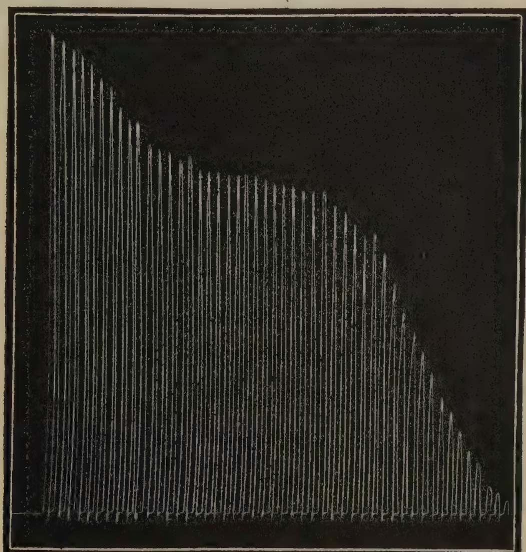

FIG. 67. — NORMAL MUSCULAR FATIGUE RECORD

This record is made by means of the instrument shown in Figure 66. Each point represents one contraction of the finger made at intervals of two seconds. The extent of movement gradually grows less until the finger is unable to pull the weight at all. (From Howell, *Physiology*, W. B. Saunders Company).

Mental fatigue. — While it is easy to demonstrate muscular fatigue it is extremely difficult to demonstrate mental fatigue. For this reason a number of wrong notions are current concerning the nature of mental

fatigue. The evidence seems to be that there is about as little likelihood of causing a breakdown due to mental fatigue as there is of causing a breakdown of an automatic telephone system through fatigue. The evidence may be summarized as follows:

1. The blood supply to the nervous system is very scanty. There is little waste material to be carried away and little nourishment required by nerve tissue. Consequently one is led to infer that there can be little breaking down of nerve tissue with use.

2. Experiments have been made to discover the effects of nervous fatigue, and only the slightest amount of effect of the most severe nervous work has been found. Indeed until very recently all attempts to show any waste products were futile. The discovery of what little has appeared awaited the development of an extremely sensitive instrument.

3. The feeling of fatigue that comes with mental work is probably even less connected with actual fatigue than is the feeling of fatigue from muscular work. Since it has little relation in muscular fatigue it should probably receive even less credence in mental work.

In spite of all this, we hear of people breaking down from mental work. When these cases are studied it has usually been found that the real cause was some emotional disturbance and that the work was a secondary factor. A student (Miss Arai) working in the laboratory of Professor Thorndike, was able to multiply four place numbers by four place numbers in her head for a period of twelve hours a day and for a succession of days with very little loss in efficiency. This is about as hard mental work as one can do. Other experiments on mental fatigue have

shown practically the same lack of mental fatigue under the most trying circumstances.

The nervous system has in itself a protective device, if it needs any. Whenever a reflex arc or other pathway is traversed there develops what is called a *refractory phase*, a period during which it will not carry a message. This can be demonstrated with the knee-jerk. Strike the patellar tendon just below the knee cap and the foot will kick out. By experiment you will find that you must wait a certain length of time after one knee-jerk before it will respond to the next. In other words, should the nervous system need any time for recuperation this mechanism would provide enough so that fatigue of any real sort would be impossible.

What is called mental fatigue is usually muscular fatigue, indifference, lack of interest, or worry. Take a text book with a lesson you do not like and after an hour's desultory reading you will be worn out. Take an interesting novel and after devouring the contents for an hour you will be fresher than when you started. It is not the mental work that you did that makes the difference. It is the attitude you take toward the task.

The best way to cure a person afflicted with ordinary so-called mental fatigue is to give him the work cure; that is, give him some mental occupation which will absorb him and he will soon forget that he is tired.

Where one is worrying about something, either closely related to one's work or otherwise, it is likely to cause trouble which may be blamed on overwork. Worry causes a change in the secretion of the ductless glands, this affects the tension of the autonomic nervous system, as has been shown above, and the result is a loss in mental

efficiency. But this loss is not the result of fatigue, it is due to the influence of the internal secretions produced by the emotions.

There is another factor which causes breakdowns to be blamed, erroneously, on mental fatigue. If one is having some sort of mental turmoil, a disappointment, some difficulty which leads to worry, a common way to get away from the brooding which results from such a condition is to attempt to lose oneself in work. This acts as a diversion for a time, but in spite of the work the unwelcome thoughts may intrude themselves. The only way to keep them out is to work still harder. This forms a vicious circle. Now the result of such a performance may be a break, but it is obvious that the work did not cause it. The more the person worked the more he feared that the trouble would come back, and, in spite of the excessive work, so it did. Then the break came. Instead of placing the blame on the work it should have been traced to the cause of the worry, and this cause dealt with in a more rational manner. Running from a worry or trying to drown it under a mass of work was a poor adjustment.

Conditions Influencing Work

There has been, and still is, much talk about the sorts of conditions that are most conducive to efficient work. We have regarded our beings as a complex bit of machinery and if they are machinery, they must be kept at the right temperature, properly oiled, and cared for, in order that they may work to the best advantage. These things hold true in the main. We all know that if we want our bodies to function, we must keep in the pink of health.

When laboratory experiments have been made to determine the influence of certain seemingly adverse conditions upon mental work, it has been found that these things do not affect us as much as we had supposed. Subjects of experiments have been given certain drugs, have been placed in rooms with bad air conditions, have been subjected to extreme strain, have been subjected to noises and disturbances, and through it all have shown a remarkable tendency to adapt themselves to any situations that may be created.

The motive behind the work is what seems to influence efficiency more than external conditions. — If one has enough of an incentive, he will put up with anything. If he has no incentive or interest in his work, then he is bothered by the slightest interference. He seems to welcome the interference as a chance to get out of doing what he does not want to do. If he really wants to do the work, the greatest sorts of disturbances pass almost unnoticed.

The study of efficiency is largely a study of the things which will give the worker a real incentive to work. These things are numerous and can not all be enumerated but we can indicate some of the more typical situations which act as incentives to good work. The reader can readily think of others.

1. *Setting a definite task to be accomplished in a certain time adds to one's efficiency.* — This has been demonstrated by the piece work system in industry. Suppose you have a group of men working at their best. Keep an accurate record of how much work they do in a working day. Then tell them that when they finish a certain amount (the amount being what they have been doing in a full

day) they may go home. You will find a sudden improvement in efficiency and the men will be going home an hour or two before the regular time.

Study as hard as you can and you may get a great deal of work done. Say to yourself, " I'll not eat until I learn this," and it will come much easier. Some students say, " I'm going to take a light schedule this term and then I can do well what I do." In many such cases the person will not do as well. Many students have found that they can do their best work when they have the heaviest load. The task itself stimulates one to better work. Lighten the load and the output of energy will lighten as well. Give yourself a real task and your energy will rise to meet it.

2. *A record of your own progress will act as an incentive to good work.* — This can be made in the form of a chart, on which you plot from day to day the amount accomplished. When you have such a plot before you, you receive from it an added impetus each day to exceed the previous day's record. You may not do it every time but it will be found that your progress is consistently better when you watch your achievement.

3. *Competition with others adds zest to work.* — This is true as long as the ones with whom you are competing are not too far ahead of you or too far behind you. Where the difference between you and your competitors is too great, you feel either that the race is hopeless or that it is hopeless for the others. The closely run race is the most stimulating. Therefore, if you use this incentive either to add impetus to your own progress, or to stimulate someone else to work harder, be sure that you set up your competition between those nearly evenly matched.

Teachers often unwittingly discourage some student, who is not quite so alert, by stressing competition. There is no incentive for a man in a mile run to continue if the rest are a quarter of a mile ahead of him, nor will the one in the lead do his best, if the next man in the race is a quarter of a mile behind him. This has been tested by letting a man run for time and against a competitor. He does better with a competitor.

4. *Interest manifested by others is an incentive to better work.* — Complimentary remarks are more effective than disparaging remarks. In addition, our attitude toward the one who manifests the interest is an important factor. Usually when one does anything worth while, behind his work there is the impulse to please someone. On the other hand, if we dislike a person we may be impelled to do poor work, if we think that person will be displeased thereby. In attempting to use the social incentive, it must be remembered that social responses must be mutual. It does no good to receive complimentary remarks from one you hate. Such a situation would tempt you to do bad work, for, by continuing the good work, you would be doing a favor to someone you dislike. On the other hand, a compliment from one you love is a very strong incentive. Many a person has received such impetus from a chance remark from one he idolizes, that his whole life has been motivated thereby.

This desire for approval does not stop with the desire for the approval of those with whom we are acquainted. It has been found that most people do better work when they are being observed, than when they are alone, even though the observers are total strangers.

5. *The presence of an ideal spurs one to greater effort.* —

Ideals are nothing more than habits. They are built up just as any habit is built. An ideal is the habitual attitude of expecting satisfaction in the future for what we are doing now. To be effective, an ideal must have some definite characteristics:

a. The ideal must not be so far distant that the individual might easily give up hope of ever attaining it. The adage " Hitch your wagon to a star " is a poor one because one never expects to mount that high, and the saying resolves itself to a trite phrase.

b. An ideal should be flexible. When one gets a taste of his ideal, then it should move ahead. If it is so far ahead that one begins to get discouraged, it should be lowered temporarily.

c. The steps from one's present position to the ideal should be clearly outlined. In this way the person knows what moves he must make in order to attain his ideal.

6. *Make a game of your work.* — We have indicated that a boy will work with tremendous energy at a game and then when he comes into the school room he will take not the slightest interest in it. If the school work can be regarded as something as inherently interesting as the game of the playground, the teacher would not have to drive the boy to work. Play is often looked upon as something that is the occupation of the lazy. This is not so. Play is the natural occupation of childhood and no one exerts more energy than a child. The difficulty comes in the fact that we are prone to teach the child that work is distasteful.

But making a game of work does not mean making it easy. It means giving the individual an incentive that will make him win the hardest task. The most suc-

cessful men in life are those who are inherently interested in their profession. It is fun for the real physician to treat people. The great lawyer looks on his work as a pleasure. The business man is in a great competitive game which gives him many thrills. This same attitude can characterize many of the activities of life.

QUESTIONS

1. Why do we honor the man who can exert effort?
2. What is the inborn background of effort?
3. How can you prove that the tendency to resist restraint is inborn?
4. Describe the sort of training that will produce a coward.
5. What is meant by the habit of success? By the habit of failure?
6. What is the difference between persistence and stubbornness?
7. How do we learn to control our impulses?
8. Why will strict control not develop a strong character?
9. Is complete freedom the best method of moral control?
10. How may an unpleasant task sometimes be made pleasant?
11. What is the relation between a work curve and a learning curve?
12. What is the relation of muscular fatigue to the feeling of fatigue?
13. What is the difference between mental fatigue and muscular fatigue?
14. Why is there ordinarily little danger of mental fatigue from overwork?
15. What is the usual cause of what is commonly called mental fatigue?
16. What are some of the best methods of increasing personal efficiency?
17. Criticize the adage: "Hitch your wagon to a star."
18. Why will a boy willingly move a pile of coal to find a lost ball and complain at having to shovel the same coal into the bin for his father?

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CHAPTER XIII

SLEEP AND DREAMS

Sleep.
  Kinds of sleep
Dreams.
  Explanation of dreams found in the life of the dreamer
  Day dreams
  Night dreams
Hypnosis.
  Suggestibility the basis of hypnosis
  Posthypnotic suggestion
  Individual differences in suggestibility

Sleep

We have seen that throughout the period of our waking life we are continually receiving impressions from the outside world through our sense organs and that these impressions are being coördinated by means of the working of our nervous system, continual responses being made. In sleep a radical change from this order of affairs takes place.

What happens in sleep? The sleeper manifests a loss of consciousness, partial or complete, depending upon the depth of the sleep. His respiration becomes slower and deeper. The eyeballs roll upward and outward and the pupils are constricted. Some of the secretions that are constant in waking life are diminished. This is true of the secretions of the tear and salivary glands especially. One of the familiar signs of sleepiness is the dryness of the

surface of the eyes, which sometimes gives the onlooker the impression that the sleepy person lacks energy.

While sleep seems to come suddenly and we seem to wake quickly, the process is, as a matter of fact, not a completely sudden change. When sleep comes, the power to make conscious movements is lost first and auditory sensibility last. On awakening the reverse holds. One may be conscious of sounds around him before he is sufficiently awake to make voluntary movements.

At times we sleep more soundly than at others. It is likewise true that the depth of sleep varies within each sleeping period. From various types of tests it has been found that one usually goes into a rather deep sleep at first. After an hour or two the sleep becomes shallower and shallower, until very gradually one comes to the point where he returns to consciousness.

From one point of view, sleep is a means whereby periodically we recover from fatigue effects. It is essentially a period of rest, and most of the things we have indicated as belonging to sleep are the result of, or are connected with, this particular function of sleep.

The thing that interests us is what happens in our mental lives during sleep. There are two ways of viewing mental life in sleep. The first is to look upon it as a sort of mysterious affair and to hunt for stories of odd things that happen. The other is to search for anything that will tend to throw light upon our waking life. One who studies psychology can not afford to ignore the mental life of the sleeper, if he wishes to have a clear understanding of psychology. But neither will it do him any good to accept any weird interpretations of the things that he may not be able to understand.

Different kinds of sleep. — It may give us a clearer understanding, if we look into the different kinds of sleep that we may have.

1. We have a *narcotic sleep*. This is the sleep induced as the result of taking certain drugs, such as ether.

2. There is the sleep of the person who has been struck upon the head. This is called *coma*.

3. There is the convulsive sleep of the one who is having a *fit* of some sort.

4. There is the *hypnotic sleep*, where one goes to sleep at the bidding of another and, while apparently unconscious to the world about him, will do things that the hypnotist tells him to do.

5. There is the *natural sleep* that we all have periodically.

The outstanding thing that is common to all of these forms of sleep is that the mental life has ceased to function in the usual manner. The difference lies mainly in the degree of change in mental functioning and the steps that are necessary to restore normal waking life.

In some types of sleep it is probable that there is a complete cessation of mental processes. This is true in the case of coma following a blow on the head. In other types there is evidence that mental functioning goes on in varying degrees. The most common form of sleeping activity is dreaming. Dreaming is an intermediary stage between waking life and profound sleep. It is even possible that in the deepest ordinary sleep dream activity is present. We can not be sure on this point, but a light sleeper is more likely to remember many more dreams than does a heavy sleeper.

Dreams

Any explanation of dreams must be found in the mental life of the dreamer. — There has been a tendency to introduce irrational explanations for dreams, just because dreams are often queer. We hesitate to admit that our minds can do the queer tricks that happen in dreams, and so we try to explain them in some other manner. The idea that dreams may be messages from the spirit world is one such type of absurd explanation.

Nor is the true explanation of dreams to be found in the fact that we ate something that did not agree with us the night before. Eating indigestible food may make our sleep light and this would give us an opportunity to dream more extensively than if we slept soundly, but the indigestion will not explain the content of the dream. It might become a part of the dream but it can not be accepted as a total explanation.

An illustration will make this point clear. Suppose that under an anæsthetic a man begins to talk about Mary. It is the anæsthetic that makes it possible for him to express his feelings about Mary. In his waking life, he would keep his feelings on this subject to himself. The anæsthetic does not put the idea of Mary into his head. His feelings about the girl are there before the sleep. The sleep merely gives them a chance to get out.

This gives us the key to dream life. (The component parts of a dream are parts of our mental life) The sleeping state removes the ordinary control that we exercise upon the play of thoughts while we are awake, and so the succession of thoughts takes on peculiar forms.

Daydreams. — An understanding of daydreams may

make it easier to comprehend the dreams of sleep. Probably every reader has experienced times when he has daydreamed. In a daydream your thoughts float from one idea to another in chance sequences. The less control you exercise, the stranger will be some of the relations between the successive ideas in your daydreams. Even in a daydream we do not let our thoughts flow freely, however; we pick and choose.

1. *Pleasant daydreams.* — In daydreaming one is very likely to do what we call building air castles. In other words, he imagines he has the things that he actually does not possess but wishes he did. Daydreaming may be a useful thing or a detriment to the individual, depending upon the effect that it has on him. It may lead to artistic creations or to idle "wool gathering." If a daydream is an incentive to attempt to achieve the things that lie beyond one's immediate sphere, it serves a good purpose. If, on the other hand, it serves as a solace for one's lack of ability, it has a bad effect. It becomes a substitute for effort. Daydreaming should be a vision of what one is attempting to be or do, and not a substitute for failure or an excuse for laziness.

2. *Worry.* — One's daydreams may assume another character in that they may be concerned with a fear of some sort. Worry is the name commonly given to this form of daydreaming. There are those who seemingly can do nothing but sit around and worry about what is going on or what they believe is going to happen. This type of daydreaming is simply another form of excuse for failure to face actual situations. Instead of getting up courage and going at it again, this type of person sits back and complains that the world is going to perdition.

Stated in other terms, daydreams are likely to be emotionally colored by either of two factors; wishes or fears. The attitudes typified by either of these emotions are valuable if permitted to operate in moderation. If carried to extreme, they violate their purpose. Fear will make a coward of one, while excessive dependence upon wishes will produce a useless visionary. Usually we try to emphasize the pleasanter type of daydreams and speak of the land of dreams as the place where everything " our heart desires " will come true.

3. *Unemotional reverie.* — There is still another type of daydreaming where little control is exercised on the thought sequences and where there is little emotional background. Such situations are not as common as we might think, however. Often when a person is supposed to be in an unemotional reverie it may be found that the content of his daydreams is highly emotional. But there is a theoretical condition, sometimes realized, where the person may indifferently just sit and let his thoughts roam. As has been said of many people: " Usually they just sit and think, and sometimes they just sit."

Night dreams. — We have taken up daydreams in detail, because they will help us to understand night dreams. Night dreams differ at different times and with individuals. Any classification is artificial and it may be expected that the same dream may partake of the qualities of different types. We will group them for the sake of study.

1. *Some night dreams may have the character of the listless reveries of waking life.* — All critical discrimination of the sequence of thought goes, and there is a mere jumble

of seemingly senseless material. This material will on examination be found to consist of elements that have been present in the dreamer's life. He may go over the work of the preceding day in almost endless succession. If he has been driving a car, he may seemingly spend the night in turning corners and avoiding collisions. This type of dream is likely to dominate when one is disturbed for some reason and is not sleeping soundly.

2. *There are direct wish-fulfilling dreams.* — A boy may long for some candy during the day. He goes to bed without having secured his candy. He dreams that he is eating barrels and barrels of candy. The dream is very real to him while it lasts and he gets perfect satisfaction eating all the candy that he can possibly desire. A great many dreams are of this sort. In some the wish is not so apparent, especially where it is for something that is not morally or socially desirable. If dreams are looked upon in this light, they will often disclose to us impulses that we did not realize clearly that we had. By such a study of our dreams it is possible to understand our motives better than by merely studying our waking life. With such added knowledge about ourselves, we should be better able to direct our acts in a rational manner. If an undesirable wish does seem to be indicated by a dream, the thing to do is not to become frightened that we should dream such a dream, but to take that as a suggestion to control that impulse.

3. *There are fear dreams.* — Just as we have seen in daydreams these are the opposite of wish dreams. Sometimes the fears can be accounted for in the waking experiences of the dreamer. At other times the fears seem absurd. In such cases it is quite likely that the thing we

appear to fear in the dream is not a real cause of fear in the dreamer's life but the fear seems to be real enough. Emotions enjoy this privilege of attaching themselves to all sorts of things and so one need not be surprised to find fears attached to various bizarre things in one's dreams. The fear is likely to be a real fear with some rational background. It might pay in such a case to endeavor to discover what the dreamer is actually afraid of and remove it. This is especially so if one persists in dreaming a typical fear dream.

4. *Dreams are likely to be allegorical.* — An allegory is the setting forth of a subject under the guise of another subject. It is an extended comparison. Now a dream may be brief so that it gives just a symbolical picture or it may be the unfolding of a complete story in disguised form. The briefer type are like cartoons. A cartoon is a disguised portrayal of something that you do not care to say in so many words. Suppose you wish to say that a politician is a thief who is robbing the public. You draw a picture of a big giant holding a little fellow upside down shaking all his money from his pockets. Lest the reader may fail to get the significance you may label the fat giant "Politician" and the little fellow who is being robbed "The Public." A dream often does something of the same sort of thing, with the exception that in the dream the characters are not labeled. It is left to you to work out the meaning. If you will look on a dream in this light, you will discover that you can find meaning in some of them that looked ridiculous at first sight. A cartoon is ridiculous until you see the significance and then it becomes very clear.

A woman once told the writer that all her life she has

been having dreams which have fitted into a complete figurative story of her whole life. This dream story took the form of traveling over vast expanses of territory. If she had a particularly glorious experience, she would dream of passing through the most beautiful country, different items of beauty representing the different specific good things that were happening to her. When she had difficulties she would dream of passing through rough mountainous country, and going over bridges that were about to be washed away and pitch her into the raging waters beneath. Through all these journeys she always pictured a distant peak toward which she was journeying. In some dreams the peak would stand out glorious and clear and in others it seemed to recede and be hidden by the mists. These dreams did not portend what was going to happen to her. They had no prophetic significance. But they did show her attitude toward the experiences she was having.

Consequently, no matter what form the dream may take, the significance lies in the fact that they reveal the deep seated attitude that one is taking toward his various life experiences.

Hypnosis

Hypnosis is a condition where one individual becomes unusually subject to the suggestions of another. — The hypnotized person becomes so wrapped in the commands of the hypnotist that his attention is withdrawn from everything else about him. It is in this sense that hypnosis resembles sleep. We have seen that in sleep the person becomes unconscious of the things about him, his senses are closed to incoming stimuli. If he is made

to respond to anything from the outside he does so at the expense of his sleep — he wakes up. In hypnosis the consciousness of the person is also withdrawn from sensory impressions. He perceives nothing except those impressions that are centered on the hypnotist.

The central fact of hypnosis is suggestibility. — By suggestibility we mean the tendency or willingness to do what others tell us to do. We all customarily take suggestions from other people; some of us are very willing to take suggestions, and some of us are less so. The ordinary person under usual circumstances takes suggestions when he is convinced from one reason or another that he will not be harmed thereby, and when it is to his advantage to take them. When we are willing to take suggestions from a person without question and to the extent that we are willing to become unconscious to everything except what he tells us, we may be hypnotized by him. One can not, however, be hypnotized without his knowledge and consent.

Recently a man asked the writer whether he could be hypnotized by strange men to the extent that they could make him leave his door unlocked at night, so that they could enter his room and steal his money. Such a thing is impossible. We read in the newspapers accounts of persons who make claims that they have done things under the influence of others who have hypnotized them. This is usually an excuse, an attempt to escape blame by placing it on another. It has been demonstrated that under actual hypnosis a person can not be made to do anything that would violate the dictates of his moral nature. If such a suggestion is given, the subject will immediately awaken from the hypnosis.

One does not have to be hypnotized to receive suggestions that are not for his good. Moral character implies strength enough to resist undesirable suggestions, and it is a poor defense, after one has made a mistake, to blame the act on another simply because he suggested it. If I am looking at a diamond and am tempted to steal it, and a friend standing by says, "Take it," I certainly can not blame him for the theft. If I take it, it is because I was partially ready to take it or I would not have followed his advice.

Posthypnotic suggestion. — It is possible to give a person a suggestion while under hypnosis which he will carry out later when he is awake. Such an act will not be carried out, if it would cause embarrassment to the person or if it should be against his moral nature. For example, a professor hypnotized one of the members of his class and told him that fifteen minutes after he awakened he would rise from his seat and yell, "Hurrah Boys." After waking the boy the professor went on with his lecture. When the time arrived to carry out the suggestion the boy was noticed to get restless. He fidgeted around as though he wanted to do something, but could not make up his mind to do it. Finally, he turned to the student next to him and whispered, "Hurrah." Here the social situation worked against the suggestion, and the result was a compromise.

Individual differences in suggestibility. — There are differences in the ease with which different people take suggestions. Some are very open, while others are very resistive. The strange thing in the stories about hypnosis that you hear is that they are usually circulated by the resistive type of person, the one who could not be

hypnotized at all. If a friend suggests something to such a person in a perfectly straightforward manner, he is almost sure that the friend has some sinister motive, and so he is very likely to do the opposite. To such a person the idea of hypnosis, where one has faith in another to the extent that he is willing to do without question what he says, is terrible. The person who realizes the advantage of getting suggestions from others, and at the same time understands that he should use discretion as to whom to look for advice, does not go around complaining that he is being influenced by others. The next time you hear a person proclaiming that he is being hypnotized by evil-minded persons, study him and you will find he is one who is of too suspicious a disposition to take advice from his dearest friend.

QUESTIONS

1. What are the principal differences between a person who is asleep and a person who is awake?
2. During what part of the night do we generally sleep most soundly?
3. What are the chief values of sleep?
4. Name the different kinds of sleep and briefly describe each type.
5. How could you tell whether a man were asleep or under the influence of a drug?
6. Why do all people not require the same amount of sleep?
7. Give the chief differences between dreams and thoughts.
8. What effect does heavy eating before going to bed have on dreaming? Explain.
9. How does a daydream differ from a night dream?
10. What is worry? How can a person avoid much of his worrying?
11. Illustrate each of the different kinds of night dreams.
12. How does hypnosis differ from natural sleep?
13. What type of person is most easily hypnotized?

14. Can anyone learn how to hypnotize?

15. Explain the following story: — A hypnotized man was given a dagger and told to stab his friend. Instead of doing so he immediately awoke from his hypnotic trance.

16. Under what circumstances might he have carried out the order?

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CHAPTER XIV

IMAGINATION AND REASONING

Imagination.
- Imagination based on past experience
- Imagination may occur in all sense fields
- Reproductive imagination
- Constructive imagination
- Two essentials in good thinking

Language.
- Development of language
- Concepts

Thinking.
- Non-productive thinking
- Directed thinking
- Assimilative thinking
- Problem solving
- Deliberative thinking

Reasoning.
- Values of reasoning
- Steps in reasoning
- Reasoning ability

Imagination

In the chapter on sensation, we learned that the only basis for knowledge is through the senses. There is no other known avenue of approach to the human intellect. In the chapter on perception, we saw how the primary stuff of consciousness is built up into the higher forms of mental life. Perception, we found, was the immediate interpretation of our sensory impressions in terms of our own past experience.

In perception the sensory stimulus or at least one of the parts of a sensory experience must be present to the senses. If some person holds up a watch before you, you get certain sensory impressions which, because of your past experiences with watches, you interpret and say, "I see a watch." This interpretation of a visual cue we have called perception.

But man is capable of reacting to an object not present to the senses. Suppose the person puts his watch into his pocket. Then you say, "I see the watch in my mind." You *imagine* the watch.

Imagination based on past experience. — Suppose my hat is lost. I may look around aimlessly for it or I may try to think where it might be. I try to imagine where I was and what I did with it. This is pure recall of previous experience in terms of images. I picture again all the scenes that might have any relationship to my lost hat.

Suppose I am confronted with the problem, "Shall I buy a new automobile?" It is in terms of a survey of the condition of my old car, of what need I have for a better car, and of the present state of my finances, that I make the decision regarding the possible future purchase. But the review of these facts may be, and probably will be, in imagination. It is not necessary actually to see the dilapidated wreck I now call my old car, nor to go to the bank and get them to permit me to see how much money I have. I do not have to take my car down the street and induce the boys to yell at me in derision. I can do all this in my imagination much more effectively.

Imagination, therefore, may be defined as the reinstatement of a perceptual experience without the direct stimulation

of the sense organs. There must be a stimulation somewhere but it may be indirect. Through association this indirect stimulation is connected with the previous sense impression and we see, hear, taste, or smell in imagination. Professor Pillsbury calls imagination "centrally aroused sensation." By this he means that the nerve impulse, instead of coming from the sense organ, comes through some other connection in the brain.

Imagination may occur in all sense fields. — As indicated above, we may have images in any of the various sense departments. We may *see* in imagination an orange, we may imagine its color, its shape. We may *taste* it or *smell* it. We may *feel* in the hand its roundness, its weight, etc. All this we can have without an orange in the vicinity.

Some people use almost any form of imagery as habit and circumstances demand. Some people, on the other hand, use one form of imagery almost exclusively. Galton, a famous English psychologist, found that many people could not visualize their breakfast tables at all. They might remember in other terms — words or something else — what they had for breakfast but could not imagine the table, chairs, dishes, the smell of the coffee, or the taste or sight of the toast. There are great individual differences in the imagery of different persons. Children seem to have more vivid imaginations than adults. In fact some children may have such vivid imaginations that they actually have difficuity in distinguishing between reality and imagination. Children's lies are sometimes thus accounted for. As we get older, images seem to be less vivid. Education seems to dull them. This does not mean that we lose intellectual powers but we sub-

stitute language, concepts, and reasoning for concrete mental imagery.

Reproductive imagination. — Images may be either one of two kinds. When the materials that are revived are relatively true copies of what has previously been experienced, we call it reproductive imagination. For example, when we try to recall the place where we spent our last vacation, it is of this type. Of course we do not recall everything. Many of the details like the number of windows and even the color of the house may be forgotten. Some parts may be wrongly reproduced, other parts that never existed may be filled in. Yet whenever the reproduction is a relatively true copy of the original experience, we call it *reproductive imagination.*

Constructive imagination. — Imagination may be of a different type. Previous experiences may be arranged into new combinations. We can easily imagine a red cat, a square plate, a man with four hands, a sheep with a dog's head even though probably no one has seen any and certainly not many of these things. When the parts are old but by association they have been grouped into new combinations it is called *constructive imagination.*

This process may occur in daydreaming, in night dreams, or in constructive thinking. Discovery and invention often consist only in putting together in new ways, parts that are familiar to almost anybody. The person who designs new homes takes parts from several homes and unites them in new ways. One must have a solid foundation of experiences, before he can rearrange them in the form of inventions. In a sense nothing is new. We can not think of anything without some sensory basis for what we are thinking. But we may be

very original in the way the parts are joined into new combinations.

Two things are essential to good thinking. — First, there must be a wealth of sensory experiences. Most of us have more sensory experiences than we use. Yet these experiences are necessary and the more we have the greater the possibilities for later use. Anything that will enrich our sensory experiences is justifiable on this basis.

Second, we must form habits of constructive thinking. A large part of this capacity is native. Probably a dog never could learn much by making a trip around the world. Some persons are similarly limited. But all of us can improve in the use of our native abilities. This is what James advises in his last law of habit. (See Page 75.)

Language

But man does not do all or even a larger part of his thinking in concrete images. He has found a short cut method. Instead of using images he uses words. It is true that he has sensations, perceptions, and images before, during, and after his use of words, but words come to occupy a more and more important place as man advances in his intellectual development.

Development of language. — We have already learned under perception how the child acquires words. We there found that by association certain sounds are connected with specific objects. The child is looking at a cat and the parent says, "cat." By repeating this several times, an association is formed between the animal and what the parent says. In this manner the sound

becomes the cue for a complete perception. "Cat" brings up a perception of the animal that the word stands for. Nouns and pronouns may thus be regarded as built up just as any perceptual cue is built up.

At first the child's use of the word is very general. His use of "cat" may mean: "See the cat!" "There is the cat." "Where is the cat?" "May I have the cat?" These differences may be indicated by inflections but later he indicates these shades of meaning through the use of verbs, adjectives, adverbs, prepositions, and conjunctions.

It must not be forgotten that these words are a kind of response. There are nervous impulses when the child is looking at the cat, when he is thinking of the cat, and when he is saying or thinking the word "cat." The word is an abbreviated type of response but in many senses it is just as effective as the object or the image for which it stands.

Most of the thinking of adults goes on in terms of words. We hear words, that is, we receive auditory stimuli. We see words, that is, we receive visual stimuli. We express ourselves in words, motor responses which become auditory stimuli for others, or we write the words, also motor responses which are visual stimuli for others. In these processes the objects which the words represent may be present at the time, they may be present in imagination, or the words themselves may carry the meanings directly.

As explained in the chapter on learning the child learns to substitute sounds and printed characters for original experiences. It is a case of substitute stimuli whereby these spoken or written words carry the meaning. "Water" means H_2O, a colorless liquid, and can carry all

the meanings or former experiences we have had with the substance. Of course the word "water" will not satisfy thirst, nor will it clean the hands or provide a bath. It is only in our thinking that it *means* the same as the real article. Water *means* a thing that can be drunk, it *means* a substance in which the hands can be washed or in which we may take a bath.

The history of the development of the language of the race is the history of the growth of intelligence. Man's superiority over the lower animals can be explained almost completely on the basis of language. Language keeps pace with the growth of civilization. The same is true in the life of the individual. At first the infant deals only with the concrete, later, with ideas and language. Education consists to some extent in the growth of language habits. The best single measure of the intelligence of an individual is the size of his vocabulary.

Concepts. — Man has the capacity to analyze and react to parts of a total situation. Animals have the capacity only to a limited extent. The cat that is shut up in a cage reacts first to the bars and later on to the latch. He has partially analyzed the situation. But it is not likely that the cat analyzed ideas. Man does, and it is this capacity that has been a most important factor in his progress. It is inseparably linked with his language, and both have been most significant in his rise above the rest of the animal world.

Conception consists in abstracting from two or more situations some element common to both or all. This means that we perceive relationships. These relationships may never have been separated from other relationships. The only way in which they are separated is in

thought. In fact in many cases it is impossible to separate them except in thought. For example, we never have seen the color red separated from other things. It is always a red something, a red house, a red sign, or a red spot. We in turn have the experiences of a red house, a red sign, and a red spot and from these in our thoughts recognize a quality common to all — and we call this redness. Redness is then a concept, a common thing in a number of experiences separated only in thought.

This process grows in a very simple manner in a child. He sees a chair. It happens to be a yellow chair. It has four legs and a straight back. He sees another chair which is smaller, brown, has four legs, and a rounded back. Then he sees another chair with rockers, green upholstery, and a low, straight back. The particular forms of these chairs differ greatly, in fact they differ so much that it is very difficult to define a chair. But all of these chairs are alike in one respect. They are all to sit on. That is, they have a common use or meaning. The usual growth of a concept consists in a narrowing of the sensory factors in experience and a growth in meanings.

This may lead to a little confusion between a perception and a conception. Let us see if we can get the difference clearly in mind. Suppose the child with the experience outlined in the preceding paragraph sees a new kind of chair. If he sees its similarity to the previous chairs he has experienced he immediately interprets the new situation and says that this new thing is a chair. Immediate interpretation of the new experience in terms of the old is perception. Suppose that we question his interpretation and ask him how he knows that is a chair. In reply he outlines the qualities that go to make up a chair — a

thing held off the floor by legs for the purpose of providing a place to sit — and gives us what we call a definition. He does not take these qualities from the experiences except in thought and it is this abstraction which we call conception.

Thinking

Non-productive thinking. — Thinking may consist in little more than a review of past events, that is, the revival of memory images. This may be a sort of aimless day-dreaming which has been described above. Much of our time may be wasted in this sort of non-productive thinking. This may lead at times to the finding of material for use in other types of thinking but too much time spent in this manner is seldom very beneficial.

Directed thinking. — On the other hand, thinking may be more directed than this. We may try very definitely to recall some event that happened a week ago. We call up one association after another in an attempt to recall what has been forgotten. This is more directed, more purposeful thinking. The aim of such attempted recall of course may be to fulfill a mere curiosity, or it may be an important link in some constructive program.

Assimilative thinking. — Much of the pupil's time in study is devoted to thinking out solutions and answers to problems proposed by teachers and texts. This is directed and purposeful thinking, but the direction is given by another. This has been called assimilative thinking. The pupil is directed to assimilate and make his own the ideas and principles that others have worked out. In this way the student adds to his stock of knowledge through specific directions.

Problem solving. — Assimilative thinking is entirely justifiable. It is much more efficient than undirected exploration by the pupil. It is often more interesting, if the pupil can construct problems of his own and solve them. But this generally takes on the aspect of pure trial and error with most of the emphasis on the error side. Problem solving is highly worth while but is usually reserved for situations where help is not readily available.

Deliberative thinking. — The highest type of thinking is that used when a person is presented with two or more possibilities. Where shall I spend my vacation? Which of these two roads will take me home? For what profession shall I prepare myself? In such situations the thinker must choose between the various possibilities presented. This is called deliberative thinking. There are no new elements in such thinking. It is, however, more original and more purposeful than the other kinds.

Reasoning

When presented with a problem or a puzzle we may use a motor method or a rational method of solution. In the motor method, we try out the actual objects. In the mechanical puzzle, for example, we may pull and push certain levers as well as try to unhook or unfasten certain locks and fastenings. Instead of using such a motor method we may try to reason out the problem. In reason we work out the possible solutions in our minds and reserve the actual trial until we have decided what is the proper solution.

Value of reasoning. — Reason has several rather obvious advantages over the motor method of solving problems.

1. *It saves time and energy.* — If I want to know how my room will look with the furniture changed, I may move it around and around until I am satisfied. Or I may move it in my imagination, and picture to myself how it will look in each position until I select the one that suits me. The latter is easier, quicker, and, for many purposes, more successful. The problem may concern the moving of a house or a whole city. Here it is very evident that the ideational or reasoning method is quicker and saves energy.

2. *Reasoning takes fewer trials.* — If every possible solution is tried, it is apparent that one would have to try a large number unless by accident he struck the right one first. In reasoning there is only one trial, the putting to work of the last one which is the solution we have arrived at in our minds. Of course if our reasoning is faulty, we may not be able to escape with but one trial, but this is not the fault of the reasoning method; it is because our reasoning is faulty.

3. *Reasoning is more economical of materials.* — It would cost a fortune to move a building, which can be moved in a moment in imagination.

4. *Reasoning uses ideational material.* — Ideas are a lot more plastic than concrete things. An engineer in Chicago can draw the design, indicate the materials, and direct the construction of a building in Los Angeles. A very interesting attempt at such a process occurred a few years ago. A football coach in Pittsburgh directed the training of a team in San Francisco. Reports were received from the assistant coaches and instructions were sent nightly by telegraph or telephone.

5. *Reasoning may also be concerned with abstract and general problems.* — This is only another way of saying

that reasoning makes use of concepts and language as well as concrete situations. In reasoning, a drawing of a triangle can stand for an isosceles, a scalene, or a right angle triangle. The solution may hold equally well for any type of triangle. The answers to such problems are called generalizations or laws. Our highest type of thinking results in the generalizations that come from the study of concrete situations.

Steps in reasoning. — What are the steps in the reasoning process?

1. *The first step is to see the problem.* — Many mysteries surround us, but most of us do not see them as problems. Apples had fallen and the heavenly bodies had revolved for countless generations. It remained for a Newton to see the problem and study gravitation. Someone has said that stating a problem is halfway to a solution.

2. *Find the solution.* — After the problem is defined the next thing is its solution. This is generally begun by a preliminary analysis and definition of the problem. We then call up related facts, the greater the number the more chance for a correct solution. Many people fail just at this point. Too often men are content to pass judgment without sufficient evidence. This is too true in political and even in the natural sciences. So often we hear men giving their opinions on things they know little about.

3. *Formulating a theory.* — But a mere collection of facts is not enough. Darwin spent years of travel, collecting facts. After the facts were collected he weighed these facts. He discovered that some were significant and others were not. Out of the significant facts he discovered the relationships which formed the basis of his theory of evolution. This is a process of study and insight. Its

success depends to a large extent on intelligence. A lesser mind might have industriously collected the data and then might never have been able to analyze them and see their significance. In addition to intelligence, training and habits of thinking are important factors in analyzing problems. This accounts in large part for the productions of some of our laboratories that are directed by great scientists.

4. *The last step consists in stating the results or conclusions.* — In mathematics this consists in getting the answer. It means the same in any kind of reasoning. This is the goal after which we started in the beginning and, practically, the work is of no value until the answer is reached.

Some have claimed that there is still another step, the proof. Some mathematics teachers require that all answers be proved. Some texts are printed without answers. In such cases the answer has to be tested or proved. Justifiable and valuable as this process may be from the point of view of teaching it is secondary to the reasoning process. It is followed because we are not sure of the integrity of our reasoning. Even the proof may be faulty in some lines.

Ability to reason. — What are the laws and principles governing successful reasoning? Are there any short-cut methods or general rules to be followed that will insure correct results with little effort? The answer to these questions is very discouraging. Wasteful and slow as most of our thinking is, there are few rules that can be laid down for improvement.

Intelligence and industry are of prime importance. Beyond these, success depends upon the carrying out of

the steps in the process in their proper order. First, we must see the problem. The seeing of the problem is partly a matter of ingenuity and partly a problem of training. Next these problems must be weighed. Some of them are not worth solving. Many people waste much time learning unimportant facts. The case of the boy learning the population of cities and towns (See page 205) is a case in point. Most of us are guilty of similar waste. Others of us waste our time trying to solve impossible problems — impossible at least to us. Of course the process may be justified on the ground that a sufficient desire to know is often the basis for a solution. But if we want to know the composition of a piece of metal we will need to know something about physics and chemistry before we attempt to solve it. Too often we try to solve problems we know nothing about. It would be better for us to solve problems we know about or at least prepare to solve them before wasting time at the actual attempt.

Too often the high-school student and even the college student is not preparing himself to solve any kind of problem. We should each be preparing ourselves to solve some kind of problem. We should collect facts. The more facts the better. We should keep studying the relations between these facts. We should learn the methods of solution and become thoroughly familiar with the reasoning process and the technique of the laboratory. If we do this day by day, even though we see little progress, we are likely, as James says, to wake up some fine day and find ourselves a master in some field of endeavor.

QUESTIONS

1. Explain what is meant by "the only basis for knowledge is through the senses."

2. What two terms are defined by each of the following?

—— is the consciousness of an object or event present to the senses.

—— is the consciousness of an object or event not present to the senses.

3. Imagine some absolutely new experience and then describe where each part came from.

4. Give an example of reproductive imagination. Is it ever complete? Explain what happens in the reproduction.

5. When is a lie not a lie?

6. By going over some of your past experiences in your imagination, try to decide which form of imagery you use most frequently and consistently: visual, auditory, tactual, kinesthetic (or the imagination of movement), gustatory (taste), or olfactory (smell).

7. What are some of the things language has done for man to advance him beyond the other animals?

8. What do you suppose would happen, if man should lose his language ability?

9. What language would be spoken by a child born of French parents reared in an English home? Would such a child have a French accent when grown?

10. What are the advantages of having a language teacher who speaks as her mother tongue the language she teaches?

11. Explain your concept of chair, horse, automobile. How does the concept differ from the percept in each case?

12. How does directed thinking differ from non-productive thinking?

13. How does deliberate thinking differ from problem solving?

14. What are the advantages of reasoning over the methods of problem solving?

15. Select a problem from your own experience and show the successive steps you used in solving it.

16. In solving a problem, are any of the steps listed in the text ever omitted or do they ever occur in some other order than here given?

17. State the laws of reasoning.

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CHAPTER XV

INDIVIDUAL DIFFERENCES

Mental Differences Important.
- Physical differences
- Mental differences

Measurement of Intelligence.
- Mental age
- Intelligence quotient
- Intelligence groups
- Group intelligence tests
- Treatment of intellectual differences

Personality Differences.
- Measure of personality traits
- Sex differences

Mental Differences Important

In much of this text we have spoken as though all men were alike. We have described the typical man. The purpose of this chapter is to point out that all people are different. That we are alike in some respects is true, but that we are different in many other respects is equally true.

Physical differences. — This fact is generally understood when physical characteristics are being considered. No one thinks that a child is physically like an adult. Among adults there are differences in height, weight, color of skin, color of eyes and hair, size of hands, feet, mouth, nose, length of waistline, and many others. These are mostly native differences.

There are other physical differences that are acquired; such as scars, the way the hair is worn, mannerisms of speech and walk, facial expressions, and other characteristics.

Mental differences. — While there is considerable physical difference between a person who weighs 95 pounds and the one who weighs 425 pounds or between the blonde Swede and the dusky negro yet these differences are not nearly as great as the differences in mental make-up between individuals. Although this difference in mental make-up is of tremendous importance, it has often been neglected or denied.

Popular opinion has often taken Jefferson's statement that "all men are created equal" to refer to mental equality, whereas Jefferson meant they had equal rights to "life, liberty, and the pursuit of happiness." Relating such a statement to equality of ability is a common trick of Fourth of July orators and seekers after popular favor.

The only serious thing about this is that so many people have been led astray by these doctrines. These false prophets have preached equality of ability and opportunity, and have failed to emphasize the principles underlying the New Testament parable[1] of the talents. This story is not meant to imply that those who have inferior talents should give up, but to indicate that each one is responsible for making the most of what he has.

Instead of looking upon individual differences as a misfortune they should be regarded as a tremendous human asset. If everybody were just like everybody else, what a humdrum existence this would be! As a matter of fact, personal differences have always been a

[1] Matthew 25: 14–28.

subject of great human interest. But it has only been recently that the problem has engaged scientific endeavor.

A great deal of the earlier interest in individual differences took the form of story-telling and fortune telling connected with a great deal of superstition. Those who were strikingly different from the average person were supposed to be possessed with good or evil spirits. Such explanations wither when we begin to apply the method of science, which is to measure and reduce to formulæ the things that we study.

Measurement of personality traits has not been an easy task. The first difficulty has been in the actual marking off of a specific trait. We still differ in our notions as to what are the essential traits. However, nothing helps as much to clarify definition as to attempt to measure. The actual measurement makes one specific, and delineation of traits will in all probability develop hand in hand with the progress of measurement.

Measurement of Intelligence

The first trait to seriously engage the attention of those interested in mental measurement was intelligence. In 1904, Alfred Binet and Theodore Simon in Paris constructed the first successful test for measuring intelligence. The scale that they devised has been revised and translated into various languages so that we now have a very reliable measure of this trait.

By actual trial, Binet found the things that the three year old child can do that the average two year old child can not. There are things that the average four year old child can do that the three year old cannot. He found items of this sort that would distinguish the

average person of different ages up to sixteen years. The items that were found to hold for each year he grouped together and these comprise the test for that year.

Mental age. — When a stranger comes for a test he is given a series of these standard problems to solve. Some of them will be too easy and some will be too hard. The highest level of his ability will indicate his position on this mental scale and the position is called *mental age*. That is, if the best problems he can do are what the ordinary fourteen year old child can do, his mental age is fourteen years. Hence, the normal five year old child has the mental age of five years. The normal eight year old child has a mental age of eight years. Mental age changes with years and for the normal child, it is always about the same as his chronological age.

Intelligence quotient. — One's intelligence can not be described merely in terms of mental age. All children with a mental age of eight years are not of the same intelligence, for one might have an actual age of six years and another an actual age of ten years. The mental age always has to be related to the actual age. This is done by means of the *intelligence quotient*, abbreviated to I. Q. in most cases. The intelligence quotient is found by dividing the *mental age* by the *actual* or *chronological age*. When the child has a mental age that corresponds with his actual age the quotient will, of course, be 1.00.[1] If the mental age is eight and the actual age six, the I. Q. will be 1.33. If the mental age is eight and the actual age ten, the I. Q. will be .80. This method of expressing intelligence

[1] Many writers omit the decimal point in expressing I. Q.'s and 1.00 is written as 100, 1.33 as 133, and .80 as 80. In speaking, the decimal point is almost always omitted. We say that the I. Q. is one hundred, one hundred thirty-three, or eighty.

in terms of intelligence quotient has the advantage of simplicity and of expressing the score in such a way that relative superiority and inferiority for different ages can be directly compared.

In calculating the intelligence quotients for adults, the mental age is divided by sixteen no matter what the actual age. This is because the sort of thing that the tests measure does not develop after sixteen. Later we may develop other tests to measure differences in mental ability above sixteen. We have not succeeded in doing so at the present time. It is quite likely that the sort of mental progress one makes before sixteen or thereabouts is quite different from the progress he makes after that time. Hence, we must not conclude from the fact that in these tests the average mental level of adults is the same as the sixteen year old individual, the adult's ability is no greater. From the age of sixteen his progress is probably of a different sort.

Intelligence groups. — People differ greatly in the intelligence quotient that they possess, according to the measures made by these tests. The table below tells the percentage of individuals having different intelligence quotients.

Intelligence Quotient	Percentage	Name Given
0 to .70	1	Mentally retarded
.70 to .80	5	Border line
.80 to .90	14	Dull normal
.90 to 1.00	30	Normal
1.00 to 1.10	30	Normal
1.10 to 1.20	14	Accelerated
1.20 to 1.30	5	Accelerated
1.30 up	1	Accelerated

In the column to the right are the descriptive terms which the different intelligence quotients represent.

Another way of naming individuals of different intelligence is as follows: idiot, imbecile, moron, border line, normal dull, normal, bright, very superior, and genius. These names are not applied on the basis of a simple intelligence test, however. The judgment which is behind these names is a clinical judgment and is made only after all factors connected with the individual have been carefully weighed.

Name Given	Intelligence Quotient
Idiot	0– .25
Imbecile	.25– .50
Moron (Fool)	.50– .70
Border line	.70– .80
Normal Dull	.80– .90
Normal	.90–1.10
Bright	1.10–1.20
Very superior	1.20–1.40
Genius or near genius	1.40 up

It is a mistake to apply such names as idiot, imbecile, moron, or genius on the basis of a single mental test. The test must be backed up by other findings. We can not stress this statement too much. Much harm has been done by giving a child a name implying that he was feeble-minded, merely because he did not pass a test given by some novice. It is better to use the terms given in the first table.

It must not be assumed that an intelligence quotient even when carefully determined tells all about a child's mental ability. Sometimes a child with an intelligence

quotient of .70 to .80 may do very satisfactory school work and show no signs of dullness while some with high intelligence quotients may seem very dull. Application, persistence, and zeal sometimes make up for slowness in ability, and laziness may counteract the ability of the superior child.

Group intelligence tests. — During the World War there was a demand for some measure of the mental ability of the enlisted men. The psychologists of the country pooled their experiences in the construction of tests and developed the test known as the Army Alpha examination. This test was so constructed that it could be given to large groups of men at the same time. The Binet-Simon test which we have just been describing requires about an hour's time for the examination of one individual. Army Alpha can be given to a roomful of men by one examiner in an hour. Of course any group test cannot be considered as accurate a measure as an individual examination, for when dealing with a roomful, one has no way of telling whether the individual taking the test is actually trying to do his best or that he understands directions. But aside from these chance factors the group tests have given good results. It is customary to give a group test when large numbers are to be examined. Those who do poorly on the group test are then segregated and given an individual examination.

One million, seven hundred and fifty thousand soldiers took this Alpha test. The highest score that could be made was 212. The average score made by soldiers was 67. Some men made a score of 200 while others made nothing. The percentages of enlisted men making the different scores are shown below:

Alpha Score	Percentage
170–212	1
138–169	4
100–137	15
36– 99	60
21– 35	15
6– 20	4
0– 5	1

This is a good illustration of individual differences.

Several thousand high-school pupils and college students have taken this same test. The high-school average is about 130. This means that the high school has selected from the ordinary population a superior group. The college freshman average is about 140 to 150. This average is higher because those who enter college are usually a still more selected group than the average high-school student.

Other group tests have been devised for measuring the mental alertness of high-school pupils. Among these are the Terman, Otis, Miller, Thorndike, and Morgan[1] group tests. These tests show the great range of abilities in high schools. They may be used as a basis for predicting success in school, provided the person has fair health and works industriously, and as a basis for vocational and educational guidance beyond the high school.

Treatment of intellectual differences. — Despite the fact that millions of school children have been given mental tests, too little correct use has been made of the results. Teachers and others have given tests and have

[1] No training is required to administer or score the Morgan Test. It is published by the Clio Press, Iowa City, Iowa.

assumed that there was some virtue attached to doing so, letting the matter rest there. A student of the writer, who was engaged in giving mental tests throughout a school, found huge piles of test papers stored away in an old desk. These tests had been scored but the results had never been recorded. These results could have been used in explaining and helping with teaching problems, promotion, educational guidance, and vocational guidance. In fact, that was just the purpose of the present testing in the school. The testing was being repeated because of a failure to make use of a previous test.

On the other hand, some are too eager in their zeal for mental tests and have failed to realize that the things that these tests measure are only one factor in school and in life outside the school. Some have tried to explain too much on the basis of mental test scores. Some have shown a tendency to brand the child with a test score and use this as an excuse for neglect. On the other hand, the real value of these tests should not be slighted because of some unfortunate attempts to try to make too great or improper use of the test scores. The object of the test is to find the child's standing and the object of finding his standing is to organize a sane program to enable him to better himself.

Starch says that in the average grade room of 30 to 35 pupils the best pupil in the room is able to do from two to twenty-five times as much as the poorest pupil. This means that a lesson that requires two hours and a half of the poorest pupil's time, may be prepared by the brightest pupil in the class in twelve minutes. Or if the brightest pupil spends the two and a half hours in study, he can get twelve and a half lessons in that time just as well as the

poorest child can get one lesson. This is extreme but it is probable that, in the average class in the grades, at least half this much difference exists. That is, the best pupil in the ordinary grade could work more than six times as well or as fast as the poorest. In high school slightly less difference in ability exists for more poor than good pupils leave school without attending high school.

These differences are shown on the ordinary examination. Yet it is not until standard tests are used that the magnitude of these differences can be accurately measured.

Personality Differences

Measurement of personality traits. — Both children and adults differ from one another in other respects than intelligence. The measurement of differences of other sorts awaits accurate delineation of these traits and methods of measurement. Some of the traits that have been segregated roughly and measured are: 1. persistence, 2. forcefulness,[1] 3. sociability, 4. personal appearance, 5. morality and character, and 6. mental balance. These measures are still in the experimental stage. When we remember that the testing of intelligence began in 1904, it appears that the growth in this field has been remarkable. The next twenty years should show equal progress in the measurement of other mental traits now that the ground has been broken.

Many attempts have been made to have friends and associates rate or judge people. This method has been used with some success in high schools, colleges, and business. Rating is very crude, however, and oftentimes tells more about the one doing the rating than it does of the

[1] The Moore-Gilliland Aggressiveness Test is a test of this kind.

one he is rating. There is an old adage that work in ratings has corroborated. It states, " You can tell more about a man by what he says about others, than by what others say about him."

Sex differences. — One other type of difference should be considered before leaving this problem and that is the difference between sexes. This is a popular topic and much is made of it in fiction. Physical differences in the sexes are apparent. Girls develop more rapidly than boys up to the age of adolescence. After this period the boys spurt ahead and on the average excel the girls in size and strength. After the age of about thirteen the mental differences between boys and girls is negligible.

A girl is interested in playing with dolls, keeping house, and very early begins to be concerned about her dress and in keeping her face washed and her hair neatly combed. The boy is more interested in playing outdoor games in which there is much running and yelling. The boy is not likely to be so interested in clothes or in keeping his face clean or his hair combed. Of course many of these differences are learned, probably most of them are taught to children by their parents and by friends, but some differences may be native. However, most of the scientific studies of the differences between boys and girls fail to show many real mental differences.

In scholastic ability there is very little difference between the boys and the girls. Girls seem to excel in reading, arithmetic, and handicrafts. In high school and college, girls get better grades in English and the foreign languages, while the boys get higher grades in history and mathematics. How much of this is due to real differences and how much to differences in marking, remains unsolved.

Some have claimed that boys have stronger traits of pugnacity and aggressiveness, while girls are stronger in the maternal instinct. How true this is and how much is only opinion or the result of training, remains yet to be proved. The fact that so many girls and women did men's work during the World War and often remained in these jobs, that women are now well represented in practically all the professions, and that differences in habits, thinking, and even in dress are decreasing, makes us question seriously any of the popular notions about sex differences.

The study of group differences, including differences of sex, has been relatively unprofitable. The study of individual differences has given much more valuable information. After all we develop as individuals and not so much by groups. The group includes individuals of many types and any study of group differences means that the real basis of difference, the individual, is swallowed up.

QUESTIONS

1. What are some of the ways in which people differ?
2. Do people differ more in physical or in mental traits? Give some justification for your answer.
3. Why have mental likenesses rather than mental differences often been overestimated?
4. What is meant by the I.Q.? How is it found?
5. Is intelligence native or acquired? Has training any influence on intelligence?
6. What is a genius? May a genius be completely described in terms of I.Q.? If not, what other attributes must he possess?
7. Who are feeble-minded? What should be done with the feeble-minded in schools?
8. What should society do for the feeble-minded? What should it do with them?
9. In a democracy are we as responsible for the care of the bright

child as we are for the care of the dull child? As a rule which type takes the major portion of the teacher's time in the schools?

10. Should the feeble-minded immigrant be admitted to the United States? How could he be kept out? What would be some of the difficulties in selecting the fittest from immigrants who could not speak or understand English?

11. What are some of the human personality traits, other than intelligence, in which men differ?

12. What are the chief personality and educational differences between the sexes?

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CHAPTER XVI

PERSONALITY

Personality as Integration.
The Elements of a Personality.

Personality as integration. — The sum total of all that we are, is called personality. The various parts of our physical and mental make-up are parts of personality. Sensations, reflexes, instincts, emotions, perceptions, imagination, memory, intelligence, and reasoning are included. But personality is more than is usually included under the above terms. Personality embraces these factors not only in relation to the person concerned but especially in relation to other people. It is in our relation to others that we are usually judged. In other words, a large part of what we call personality is social in nature.

Under the term personality, all the factors are joined together in a unity. As a child grows up, his original nature is modified by various experiences. It takes a long time for us to grow up and become men and women. We are continually learning new things and forgetting other things. As one grows, he assimilates the different experiences that he encounters, and unifies them. This unification is the first essential of a well developed personality. We are not the same today as we were a year ago. Things have happened in the year. If we should compare ourselves now with what we were a year ago, in some ways we would hardly recognize ourselves.

Yet we are the same personality. The uniting of all our experiences into personality is called *integration.* Integration is a process which is so complete that the whole is just as much a unity as each of the parts of which it is made up. Complete integration is the ideal of personality. Any breakdown in this unity is a very serious matter.

The elements of a personality. — It has been shown that personality is a unity, and yet we may analyze this unity into some essential parts in order to get a better understanding of it. What are the factors in personality? What are the important elements in describing a person? How may you describe one person to distinguish him from everybody else?

There are many ways in which we might classify personality. A complete classification would be almost impossible, because the factors involved are so numerous. Still the outstanding traits in which people differ are relatively few. We will try to select only those that play the most important part in man's social adjustments and will take up in turn: 1. intelligence, 2. emotionality, 3. personal appearance, 4. sociability, 5. forcefulness, and 6. character or moral traits.

1. *Intelligence.* — By intelligence is meant the ability to meet and solve the problems of life. In general it is closely allied with the ability to learn. It is not the problems that we have solved or what we have learned, but it is the ability or capacity to learn or solve these problems. Individuals differ greatly in this capacity. In an earlier chapter (page 296) we have shown how this capacity varies among individuals. Some people have very much greater intelligence or mental alertness than others.

Mental alertness without doubt is the most important single human trait. If it were possible to have all the other traits in abundance, without intelligence human capacity would be nil. (It is true that this trait in itself is not sufficient.) A man with a large degree of intelligence and with little forcefulness or persistence will not get far in life. A man with much intelligence but with a weak or perverted moral character may be a very dangerous member of society. As we have already pointed out and shall continue to emphasize in this chapter, a well-balanced or well-rounded personality is what is most desired in any individual.

2. *Emotionality.* — Emotionality has a large part to do with personality. The two extremes of emotionality are pleasantness and unpleasantness. Some of us are predisposed to pleasant dispositions and others to unpleasant. These states may be weak or they may be very strong. Under this general heading we may distinguish four sub-types.

a. The elated type. There is the individual who is continually elated. He is too happy, too active in his emotional life. This is a sort of silly, unfounded, superficial giddiness. The individual cannot take things seriously and is therefore getting into endless trouble. As was pointed out in the chapter on Feelings and Emotions, one should develop a wholesome, optimistic outlook on life but it should be a balanced and reasonable optimism.

Look to chp for extensive study.

b. The depressed type. The depressive attitude is another type. This type of person is just the opposite of the elated type. This type of person always sees the dark side of things. If it is a clear day to-day, that simply

means that it can not stay clear and means that to-morrow probably will be rainy. He is moody and can not enjoy what is here because of his continued emotional depression.

c. The irritable type. The irritable attitude is a third type. This person is hotheaded and given to violent scenes. He does not incline to be either happy or sad, but goes through the world with " a chip on his shoulder " daring anyone to knock it off. He is looking for fights and usually finds them.

d. The unstable type. The unstable person is at one moment elated and at another depressed with no seeming cause for the change. You never know in what mood you will find such a person, but you are sure to find him one way or another.

These are all types of deviations from the normal. A wholesome, normal emotional attitude toward life is a matter of long and careful training. Too often such development is left to chance. As has already been shown (page 242), the training of the emotional life is just as important and just as difficult as the training of the intellect.

3. *Personal appearance.* — Personal appearance cannot be neglected in estimating one's relation to his fellows. " Looks " is no small factor in success or failure. In fact entirely too much importance has been placed upon this trait in the selection of employees and even friends. By personal appearance we mean not only height, weight, features, and complexion, but also voice, dress, and other intimate personal characteristics. It is really a combination of several of these factors that go to make up what we call a pleasing or a displeasing personal appearance.

The degree to which one is pleasing or displeasing

depends partly on factors which are beyond our control. We are not all good looking. But a pleasing appearance is more than mere " good looks " or good clothes. Even old clothes may be neat and clean, and an ugly face may actually be admired in a person with a kind disposition and good manners. A pleasing personality depends largely on the kind of habits we form. We should constantly endeavor to cultivate friendliness, neatness, and helpfulness, not only because it will bring us success in the narrower sense, but because it will make us more useful and happier citizens.

4. *Sociability.* — The small child is not socially inclined. He tends to be individualistic and at first not greatly interested in people. Gradually an interest in people develops. The child, thrown in company with other children, learns to play with them. But it is a big task for the child to learn to give and take. Such coöperation, except upon an instinctive basis, is beyond the capacities of the lower animals and, as has just been intimated, it develops only gradually in the child.

The extent of this interest in others and the extent to which the individual learns to adapt his life to the life of others, varies greatly with different people. Two extremes may be described.

a. The objective or extrovertive type. Extroversion means turning out or away from. The extrovertive individual is the one who meets every social situation in an objective manner. He is interested in other people more than in himself. He is open and frank in his social relations. He tries to hide nothing and most individuals can read him like a book. This seems to be a type idealized by Americans. Peoples of other nations, particularly

the Orientals, seem to think that we overemphasize this type and it may be that we do.

b. The subjective or introvertive type. This type of person turns in to himself whenever he encounters a difficulty in the environment. He is especially concerned with himself. He is given to meditation and reflection. This attitude tends to restrict the social aspect of his personality until the person becomes indifferent to the presence or opinions of those about him.

It may be hard to distinguish between these two types. As a matter of fact we all may have tendencies of both sorts. A psychologist in giving a public address on this subject once told his audience how to distinguish the two. He said, " A good way for you to distinguish whether your main tendency is toward introversion or extroversion is this: If, as I talk, you wonder which type you yourself are — you are an introvert, if you wonder which your neighbor is — you are an extrovert."

Since it is so important in modern society that we learn to get along with others, let us digress and consider for a moment the certain specific defects that result from a lack of adjustment. These effects are quite numerous and complex but three important ones follow:

a. Hate and suspicion. A person may blame others for his lack of adjustment. He may begin to believe that other people are all vile, dishonest, and unworthy and he alone is worthy of respect. He may spend all his energy defending himself from the supposed viciousness of the rest of mankind. In such a battle he is sure to lose, because he alone is in the wrong from the start and so develops more hate and suspicion as time goes on. He may even become sure that others are directing all their energies to destroy him,

and his existence may become a veritable torment. Hence, when you do not get along with others do not blame them. To do so will only increase the difficulty. You will be as foolish as the soldier who thought that the whole company was out of step with the exception of himself. The cause is more than likely in your own personality. Train yourself to get along with people and you will vastly enrich your life.

b. Seclusiveness. One may decide that the best way to meet the inability to get along with people is to retire into oneself. This kind of person does not hate people; he just has nothing to do with them. He considers the business of life the working out of his own salvation and is perfectly content to permit everyone else to go his own way. He cares for no one and believes that no one cares for him. Such a person is not bashful in the presence of others, he is indifferent. There is no attitude toward society that will hinder one's development quite as successfully as this one. We have seen that the development of personality is adjustment to experiences. This type of person cuts himself off from a large part of the normal social experiences of life and so inevitably dwarfs himself.

c. Peculiar tricks to get recognition. The third method of meeting one's lack of social adjustment is to adopt some trick to get the attention of others. Such a person may magnify his infirmities and difficulties, expecting thereby to get sympathy. He usually gets less. Or, he may be bad in order to convince others that he has a lot of stamina. What a thrill some persons get from the recognition they get from society when their name appears in the papers, even if it is the result of some immoral act! Such a method obviously defeats its end. One person

may ape the peculiarities of someone he admires, hoping to get some of the admired individual's glory. Another may put up a bold front and try to bluff his way into the good graces of his comrades. How much sham there is in those who seem to dominate others! Some join organizations to get the benefit of the prestige they gain from such membership. One can almost measure the degree of failure of a man by noting the extent to which he adorns himself with the insignia of rank, and the pain with which he grooms himself to make such a sham impression upon his fellows.

5. *Forcefulness.* — To return to our elements of personality, we come to the fifth, forcefulness, another human trait essential to success. Too often do we see very bright individuals who fail to make good through lack of forcefulness or persistence. They may not be actually lazy but they lack tenacity of purpose and effort. Many a man with less actual ability will outstrip such a person by dogged persistence. We often hear students tell what they are going to do when they get through school or college, but one of the best measures of future success is the measure of how well present tasks are being solved. Of course there are exceptions to this rule. Some people gradually or suddenly wake up to the fact that they are not applying themselves as devotedly as they might. Ability plus persistence is a pretty good formula for personal success.

6. *Moral character.* — Morality is simply the social judgment as to whether we have developed in proper balance the various traits of our personality. In trying to meet the approval of social judgment a person, if not careful, may develop a negative type of so-called virtue

which consists in simply avoiding anything that society says is wrong. Morality does not involve a negation of self for the good of society. The first ideals of morality are personal ideals. Early in our lives these are developed, just as any habit is developed, by means of the conditioned response mechanism. As the child gains in years he gains social ideals in the same way by the process of habit formation. The truly moral adult is the one who has cultivated habits which make him do things for the good of society. Of course the man who is good because he is afraid to be bad is better for society than the one who is actually bad, but the real citizen is the one who needs no forceful restraint; he is moral by habit.

There are undoubtedly other traits that should be included in this list. Personality cannot be fully described in terms of the six traits given. But if these are properly integrated one has made at least a good start in personal development.

These traits do not develop in an orderly or regular fashion. One trait may be developing rapidly while the others are at a standstill, or even at the temporary expense of the other traits. But normal growth demands that each in turn receive the proper attention. As has been stressed so often the aim is a well rounded development of all the human traits. One of the aims of psychology is to help in understanding these problems and to indicate methods for securing the best possible results in personality development.

QUESTIONS

1. Why is personality not classified under sensation, perception, memory, reasoning, etc.?
2. What is integration?

3. What results from a lack of integration?
4. What is the practical value of a classification of personality?
5. Name the chief personality traits.
6. Why is intelligence ranked first among the personality traits?
7. Why is a balance among the personality traits so essential?
8. Can you recall examples of each of the types of emotionality?
9. Which would you consider the most serious emotional disturbance?
10. Why is personal appearance not a fair measure of real worth?
11. Is sociability a native or learned trait?
12. Name some occupations in which sociability is a very important asset.
13. Name one in which sociability is not an asset.
14. What are some common ways that some people try to compensate for poor social adjustment?
15. Point out the importance of forcefulness as a characteristic trait. Must a man be intelligent to be forceful? Explain.
16. Define morality.
17. Why is the recluse not classified as the highest type of morality?
18. Show that morality is a habit.
19. Is the small child moral, immoral, or unmoral?
20. What part has fear in preventing immorality?

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add: Table manners etc
value of being well-dressed

INDEX

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Genevieve
Slave